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USSR Report

ENGINEERING AND EQUIPMENT

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USSR REPORT

Engineering and Equipment

Contents

Briefs

REVOLUTIONARY ROTARY LINES

Moscow PRAVDA in Russian 20 Mar 86 p 2

TARASOV, A., special correspondent

[Abstract] At the invitation of Academician L. N. Koshkin, the author visited a shop using a revolutionary new rotary production line in which an entire shop, including ten operations (presses, in this case), has been reduced to a single module. Machine tools, people, boxes of parts, trucks, storage areas, all have been compressed into a compact "box," increasing the speed of output of finished parts by a factor of ten. Both the part and the tools to work on it move around in a circle, rather than the part moving down a conveyor line with many separate tools. Rotary and rotary-conveyor production lines are now in use in the Soviet Union to produce a wide variety of parts, always at reduced cost and in reduced periods of time.
[280-6508/5915]

UDC 621.9.04

PHYSICAL AND PRODUCTION PROCESS MECHANISMS FOR DEVELOPMENT OF FUNDAMENTALLY NEW METHODS OF MACHINING MACHINE BUILDING PRODUCTS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 2, Feb 86 pp 18-27

PODURAYEV, V. N., doctor of technical sciences, professor

[Abstract] Plans call for the development of fundamentally new methods of machining machine building products in order to improve labor productivity by a large factor. Priority directions here are: 1) Maximum utilization of the latest achievements of the basic sciences. 2) The utilization of all possible physicochemical effects for the purpose of manufacturing machines. The use of combined methods utilizing the successive or simultaneous effects of a number of mechanical, thermal, electrical or magnetic processes has proven especially effective. 3) The optimization of production processes based on the utilization of program and adaptive control systems, including the utilization of computers. This direction includes the use of computer-aided design systems. 4) The development of methods enabling the efficient mastery of flexible

manufacturing and flexible computer-integrated systems. Engineering approaches are discussed toward designing new methods of machining along these four directions. The principal potential for developing fundamentally new production processes in machine building is through basic research, which makes it possible to construct mathematical and design models of cutting processes, i.e., all methods of making parts by removing a certain layer from the workpiece. The basis of any cutting process is failure of the material being machined, be it through mechanical, thermal or chemical means. Combined failure mechanisms occur most often in actual cutting processes. Combined methods are formed by supplying two or more types of energy to the cutting region and combining various methods of supplying them. Sometimes a combination of two physical effects can produce new technical results enabling a radical improvement in machining efficiency, tool durability and the quality of manufactured parts. The criterion for the compatibility of physicochemical processes is the total amount of the machined material removed per unit of time by the combined cutting process; it must be greater than the arithmetic sum of the amounts removed by each process individually. Cutting methods in which one or more cutting condition parameters change in value in the process of removing a single layer of material ("nonstationary" method) are employed in program and adaptive control systems. Flexible manufacturing systems are developed at the present time primarily on the basis of multipurpose CNC machine tools. Fundamentally new methods must be used for organizing the production of new types of products by means of flexible manufacturing systems. The shape of a part must be designed in accordance with the available set of tools used by these systems. Production processes and machining methods must be developed and used which are not those which are generally practicable, but which are technically feasible in a given production system, and it must be convenient to formalize these processes and methods for the purpose of the development of algorithms and the use of computers. References: 2 Russian.
[226-8831/5915]

UDC 621.952.8

DRILLING DEEP HOLES

Moscow MASHINOSTROITEL' in Russian No 2, Feb 86 pp 22-23

LEBEDEV, Yu. V., engineer

[Abstract] Most problems in drilling deep holes are caused by inadequate stiffness of the drill shaft, and use of collets is not always practical or even possible. A drill with variable active length is proposed instead. The drill bit is clamped in a feed mechanism and the work piece is mounted on the spindle of the machine tool, lubricant-coolant fluid being fed from an oil vat. As the hole deepens, the drill feed mechanism releases more of the shaft length until the entire bit is engaged at the end of the drill operation. The principle of this length regulating device is based on friction between the drill shaft, continuous with one clamp or periodic with two alternately engaging and releasing clamps. One clamp always moves in the direction of

drilling. In the case of two clamps, holding one stationary will result in an intermittent drilling operation with chip crushing by kinematic action. The feed rate can be regulated, whether the clamp drive is mechanical, hydraulic, or electromagnetic. With this device it is possible to drill holes 10-60 mm in diameter 500 mm deep or deeper. Threading the shaft in the direction of feed will improve the reliability and lengthen the life of the drill bit. Consolidation of the rotary drill drive, the drill feed drive, and the clamping device into a single module will simplify the construction. Figures 3. [221-2415/5915]

UDC 658.52.011.56.012.3:621.865.8-229.62

UNIVERSAL CARTRIDGE-BIN FOR ROBOTIZED PRODUCTION COMPLEXES

Moscow MASHINOSTROITEL' in Russian No 2, Feb 86 p 14

KRUGLOV, S. I., engineer

[Abstract] A universal cartridge-bin for loading and unloading stations in robotized production complexes has been developed at the Gomel KTEI for Retooling and Production Setup at Minzhivmash Enterprises. It has a large capacity and can handle parts of various shapes. Baskets holding the parts slide down a coil-shaped rail under gravity. They are hoisted back to the top by a vertical conveyor. An interceptor at the grip location separates an unloaded basket from the loaded ones. The conveyor runs until all the baskets are full (empty) after a loading (unloading) cycle, and stops when an empty (full) basket strikes the mechanical sensor at the interceptor. Figures 1. [221-2415/5915]

UDC 658.52.011.56.012.3-192.658.52.011.56.012.3:621.941.23-529-192

IMPROVING TECHNOLOGICAL RELIABILITY OF LATHE OPERATION IN FLEXIBLE COMPUTER-INTEGRATED MANUFACTURING

Moscow MASHINOSTROITEL' in Russian No 2, Feb 86 pp 12-13

ZHUYKOV, V. A., engineer and APATOV, Yu. L., candidate of technical sciences

[Abstract] Use of lathes in flexible computer-integrated manufacturing systems with numerical control is problematic for three reasons: 1) low productivity with fewer than three cutters operating simultaneously and the high degree of complexity of a conventional multicutter setup; 2) final adjustment of a control program for precision alone requires much more time than execution of the program itself; 3) the continuous need for change of tool setting and of cutting mode, to accommodate a broad diversity of parts to be machined, so that vibration-free operation is hard to achieve and random variations added to systematic changes cause instability of the product quality indicators. Use of multicutter lathes would be desirable, therefore, if their complexity can

be reduced. This approach was taken by the Department of Machine Construction Technology at the Kirov Polytechnic Institute in developing a multicutter tool head for turning large stepped shafts with all cutters in one plane perpendicular to the shaft axis. The performance of such a head was evaluated in a model 1K62FZS1 lathe on 480 mm long blank shafts 16 mm in diameter made of St45 carbon steel or 30 CrMnSiA alloy steel. The quality indicators of such a multicutter machining were compared with those of machining by a single cutter and by two cutters, the results indicating no significant differences in longitudinal and transverse dimensional errors. A more flexible part machined by the new method 2 mm deep at a lathe speed of 1200 rpm and a feed rate of 0.15 mm/rev was found to be of class 8-9 precision. Multicutter machining offers much more favorable process dynamics, namely absence of torsional vibrations and attenuation of other forced vibrations with increasing depth of cut as well as attenuation of self-excited vibrations with decreasing stiffness of the machined part. Use of the proposed multicutter head for progressive machining with advance plastic deformation will abate several detrimental factors such as instability, heating, and parasitic forces. The basic design and configuration of this multicutter head are covered by patent disclosure No 1,115,853 and patent application No 3,559,658. There are several modifications, one of them covered by patent No 484,937 and patent application No 3,777,461. Figures 2.
[221-2415/5915]

UDC 658.588.8

CREATIVE SEARCH

Moscow MASHINOSTROITEL' in Russian No 2, Feb 86 pp 25-26

ODOBETSKIY, Yu. V., engineer, POPOV, V. Ya., engineer, PLYUSNIN, B. V., engineer, and MAKEYEV, G. M., engineer

[Abstract] A special office for maintenance and repair of production tools with numerical control has been established, with an organization and facilities creatively designed for smooth and efficient operation. Four field crews do setup and adjustment work, two workshop crews do repairs, diagnostic and inspection testing is done only with modern electronic equipment, the inventory system ensures fast and efficient retrieval of spare parts repair hardware even in the case of unscheduled or emergency shutdowns, and the payroll accounting system covering both labor and professional personnel is based on fairness and cost effectiveness. Creative innovations include a mobile test station proposed by S. V. Agapov, head foreman, with instrumentation put together by S. V. Grigoryev, a special work bench designed by S. F. Barabukhin, and a special tool set used by the top-notch locksmith N. P. Kotsov. Services provided by this office have reduced downtime of metal cutting machine tools by up to 2.5% in 1984 and up to 5% in 1985 (percentage of total operating time), have reduced the product reject rate, improved the labor discipline, and have met the growing demand for maintenance with a negligible increase of personnel. Consolidation of expertise and job assignments on a geographical basis have significantly contributed to these achievements. Figures 3.
[221-2415/5915]

UDC 621.822.5

COMPARATIVE STABILITY ANALYSIS OF SPHERICAL GAS BEARINGS WITH VARIOUS SLEEVE OR ROTOR SURFACE PROFILES

Moscow MASHINOVEDENIYE in Russian No 1, Jan 86
(manuscript received 6 Aug 84, after completion 19 Feb 85) pp 100-107

KARPOV, V. S. and PROKULEVICH, L. A., Leningrad

[Abstract] Vertical static gas bearings with a periodic surface profile either on the stationary sleeve or on the rotor are considered under light load. For a stability analysis by the method of circular trajectory, assuming an ideally balanced rotor, the equation of motion for the center of inertia and the Reynolds equation for the gas pressure are formulated in terms of small perturbations affecting the gas pressure, the film thickness, and the distance from rotor axis to sleeve axis, that distance being referred to the minimum radial clearance in the coaxial position. Inasmuch as this position is least stable, its stability limit is determined upon inclusion of the surface profile parameters into the gas pressure distribution with appropriate boundary conditions. The system of equations in this form has been solved numerically by the method of finite differences for a salient 3-lobe rotor with or without a ventilating slot at one side of each lobe, with either the rotor or sleeve surface being smoothly cylindrical, also for either rotor or sleeve with one or two pockets symmetrically cut along each lobe in addition to the ventilating slot. A comparison of the stability curves for all eight configurations, namely the dependence of the apparent rotor mass (referred to the ratio of centrifugal force to axial pressure force) on the compressibility number in each case, indicates that a bearing with smooth sleeve and one pocket in each rotor lobe is most stable under small perturbations and, therefore, most suitable for high-speed machines operating under light load. Figures 5; references 8: all Russian.
[212-2415/5915]

UDC 621.06

PROBLEMS OF DOMESTIC MACHINE TOOL INDUSTRY AND HIGHER EDUCATION

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 2, Feb 86 pp 14-17

PRONIKOV, A. S., doctor of technical sciences, professor

[Abstract] The machine tool industry's most urgent problems are discussed briefly, with emphasis on the training of personnel to solve them: 1) the development of flexible manufacturing systems and component machine tools; 2) improvement of the quality and reliability of production equipment; 3) the development of methods of testing and diagnosing machine tools; 4) the development of computer-aided design methods for machine tools and machining

production processes. Flexible manufacturing systems call for revamping methods of training engineers. In the 12th Five-Year Plan period production-ready models of equipment are to have reliability indicators which are not less than 1.5- to 2-fold higher than those of current products. More high- and extremely-high-precision machine tools are to be produced. Special courses must be introduced, such as "Machine Tool Dynamics" and "Machine Tool Reliability." It is necessary to have an objective evaluation of product quality. Existing methods of testing machine tools at the experimental model stage do not provide a guarantee that a machine tool which has passed the tests will meet specifications in the process of longterm use. A testing and diagnosis system for testing machine tools by the programmed method has been developed at the metal-cutting machine tools and automatic machines department of Moscow Advanced Technical School imeni N. E. Bauman. A necessary condition for speeding scientific and technical progress in the machine tool industry is the development of computer-aided design methods which include the selection of optimal alternatives, simulation of the operation of complex systems, the forecasting of quality and reliability parameters, evaluation of the effectiveness of decisions made, and the utilization of a data bank for standard and unified assemblies and components. Flexible curricula must be developed at higher educational institutions to permit the introduction of the latest achievements in science and technology into the educational process, to utilize more fully the scientific potential of leading students, and to permit integration with leading scientific and engineering establishments. [226-8831/5915]

UDC 519.95:62-50

METHOD OF OPTIMIZING PARAMETERS OF ELASTIC MANIPULATORS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 1, Jan 86 (manuscript received 23 Jun 83) pp 131-132

ROSLYAKOV, A. P.

[Abstract] A method is proposed for design optimization of robot manipulators with elastic members only, specifically for optimizing the lengths of members under the requirement that any point within a given space be accessible. This requirement is expressed in the form of a single geometrical inequality. The two other constraints, adequate mechanical strength of the members and minimum deformation-related displacement of the manipulator terminus, are each expressed in the form of three inequalities. The problem is to minimize the mean 'over the work envelope' generalized forces necessary for maintaining the manipulator in an equilibrium position. The 8-step algorithm of minimizing this target function J, a function of the lengths of members l, under the given seven constraints derives from two properties of that function: $J(tl) = t^4 J(l)$, and $l = 0$ is its only global absolute minimum. It is also based on a theorem defining the set in which a minimum of that function belongs as well as the necessary and sufficient condition for its belonging there.

It is validated by a theorem about convergence to a local minimum of that function. The problem and the constraints are formulated specifically for manipulator members of cylindrical shape. References 4: 2 Russian, 2 Western (both in Russian translation).
[270-2415/5915]

UDC 531.38

STABILITY OF UNIFORM ROTATIONS OF GYROSTAT ABOUT VERTICAL MAIN AXIS ON PERFECTLY SMOOTH HORIZONTAL PLANE

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 50, No 1, Jan 86 (manuscript received 19 Apr 84) pp 73-82

BELIKOV, S. A.

[Abstract] The movement of a massive rigid body under the influence of gravity on a perfectly smooth horizontal plane is investigated. The body is assumed to contain a cavity and to be rigidly secured to the shaft of a symmetrical gyroscope that turns without friction in the cavity. The surface bounding the body is assumed to be convex such that the only point that contacts the horizontal plane has a defined tangent plane. The Hamilton function assigning the canonical equations of motion are derived and solved partially. The Hamiltonian is expanded in the vicinity of the corresponding equilibrium position for a system with two degrees of freedom. The condition in which the gyroscope does not turn with respect to the frame, i.e., the gyrostat represents an ideal rigid body, is compared with the case in which the frame is in equilibrium and the gyroscope continues to turn. Analysis shows that the latter mode is preferable from the viewpoint of stability of the rotation mode. Figures 1, tables 2, references: 21 Russian.
[267-6900/5915]

UDC 678.062:678.046.2:678.027.3.620.178.5

PROCESSING OF FILLED MIXTURES WITH DOUBLE-SCREW EXTRUDER OF ORIGINAL DESIGN

Moscow KAUCHUK I REZINA in Russian No 2, Feb 86 pp 17-20

LYUBARTOVICH, S. S., TRETYAKOV, O. B., UDAL'TSOV, V. V. and KOROTKOV, V. A.

[Abstract] Conventional extruders now in use in the USSR and abroad are either dual machines with a single V-form feeder head and product extraction perpendicular to the axis of both screws or single machines with two feed holes and one forming tool. The latter version is simpler and more economical in size as well as cost, requires only one drive instead of two and less cooling but also precise centering of both screws on two bearings each rather than in a "floating" cantilever arrangement. In an attempt to further simplify the

design, a feasibility study was made regarding a double-screw extruder with mutually engaging oppositely threaded screws, two feed holes, and a single forming head. The design is based on a theoretical analysis of rheological relations, a power-law flow-pressure characteristic ($1 \leq n \leq 3$) being assumed for rubber mixtures or oligomers with filler, from which the mass yield can be calculated so that bilateral feed and unilateral feed can be compared with respect to productivity. The experimental prototype of such an extruder was built according to a new design, with a water circulation system for both cooling and temperature regulation over the 15-90°C range independently in three zones (two feed zones and one forming zone). The forming tool was a set of interchangeable profiled disks 10-50 mm wide and 5-20 mm in diameter for producing parts of various sizes and shapes from materials with widely ranging viscosity, with an adjustable hydraulic drag in the forming head. Rubber mixtures were fed manually, after preliminary homogenization in an intermittent-action mixer with a Z-form wheel. Two rubber mixtures, 100% SKMS-30ARKM-15 and 80% SKI-30 + 20% SKMS-30ARKM-15, as well as oligobutadiene-diene paste with carbon filler (P245 technical-grade carbon) added in 0.5:1, 0.65:1, 1:1 weight ratios were processed in this way. The screw speed was varied over the 10-57 rpm range and the power of the electric drive motor was measured at each speed. The temperature of the mixture and the productivity in terms of mass yield, were measured as functions of the screw speed, for an evaluation of the extruder performance characteristics. These measurements together with viscosity tests and microstructural analysis indicate that a continuous single-pass process with this extruder is not adequate for filled oligomer paste, a multipass process being required for sufficiently fine dispersion of the carbon filler. The extruder with cold feed and low hydraulic drag in the forming head is, however, excellent for producing rubber stock items of various shapes. Figures 4; tables 3; references 8: 7 Russian, 1 Western.
[261-2415/5915]

TAKING COST-EFFECTIVENESS INTO ACCOUNT IN METAL AND MACHINE PRICES

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 2, Feb 86 pp 66-69

ALFEROVA, T., candidate of economic sciences

[Abstract] The cost of performance improvements in the metals and machines used in an industry is usually considered by passing the cost along to the user in the form of price increases, which are usually recovered by the user of the equipment from improved performance, durability and efficiency at his end. The procedural and instructional documents in force in the metallurgy and machine-building industries at the present time provide special methods for taking into account in the price structure the impact of changes in the service life as well as savings in operating costs where the product is used. Unfortunately, the complexity of the price-setting structure in a number of cases results in the price mark-up factors for rolled metal products and machines being applied twice; this has a negative impact on the level of prices for the end machine products and the actual cost-effectiveness of their use. This assertion is supported by a brief review of some data from the USSR Central Statistical Administration and the USSR State Committee on

Prices for the road construction machine-building, agricultural machine-building and heavy machine-building sectors. The present formula for the determination of the economic impact of new equipment use when setting prices is given and this paper proposes a correction factor to compensate for the dependence of the economic impact of the end product on the quality of the metal used in the machinery. From this analysis of the overall cost-effectiveness of such improvements, it is not expedient to set the incentive price mark-ups for machinery and equipment on the basis of just the increased service life and the reduction in operational expenditures alone. The proposed correction in the economic impact factor for the calculation of incentive mark-ups in prices for highly efficient equipment will mobilize the primary reserves for improving service life and reducing the metal input requirements. Improving the methods of distributing the economic impact among the producing and consumption sectors, and taking it into account in the prices, will stimulate the output of highly efficient equipment and prevent the duplicate consideration of cost-effectiveness in prices for machine-building products and also create the conditions for further stabilizing and reducing wholesale prices through scientific and technical progress and product quality enhancement. Tables 1.
[251-8225/5915]

UDC 621.226.5

DESIGN OF HYDROMECHANICAL TRANSMISSION FOR EXTREMUM OF SYSTEM PERFORMANCE INDICATORS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 86 pp 23-26

CHEREDNICHENKO, Yu. I., candidate of technical sciences

[Abstract] Since the design of a hydromechanical transmission depends on the required preformance of the system it is part of, a procedure is proposed for designing one so as to optimize the system performance characteristics. Application of this principle is demonstrated on a hydromatic transmission for a motor vehicle, a transmission consisting of a hydraulic torque converter and a mechanical gear train with fluidic power control. The design problem is selecting the basic dimension of the torque converter, namely its diameter, then the gear ratio and thus also the number of stages, then the kinematic load characteristic of the torque converter. As the vehicle performance criterion has been selected the vehicle acceleration time, which has a minimum as function of the converter diameter and as a function of the gear ratio. The acceleration time depends on the final speed to be attained and as the latter increases, so do the converter diameter and the gear ratio corresponding to the minimum acceleration time. Also the gear ratio is a function of the vehicle speed and its selection must be coordinated with the minimum acceleration time as well as with the kinematic load characteristic of the torque converter, namely its closest fitting power-law relation. All relations are plotted on graphs on the basis of computer-aided numerical experiments. A vehicle performance indicator other than the acceleration time can be similarly treated as criterion for design and selection of the hydromechanical transmission. Figures 7; tables 1; references 3: all Russian.
[305-2415/5915]

UDC 621.822.574

EXPERIMENTAL STUDY OF DYNAMIC CHARACTERISTICS OF TWO-CAVITY GAS STATIC BEARING

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 86 pp 30-31

CHEGODAYEV, D. Ye., candidate of technical sciences, SHAKIROV, F. M., engineer, and POPOV, A. I., engineer

[Abstract] An experimental study of a gas static bearing, a dynamic system with relaxation damping, was made for the purpose of verifying that all of its amplitude-frequency characteristic curves for all values of the damping ratio pass through a fixed common point. Measurements were made on a vertical two-cavity bearing between a stationary yoke-housing and a hollow cylindrical plunger free to move inside. The two cavities in the plunger were a main cavity under the piston head receiving compressed air through a throttle and a damper cavity above connected to the main cavity by another throttle, through the piston head. Air under a pressure of 0.8 MPa was passed through a desiccator (silica gel) and a reducer directly to the gas bearing for centering the plunger and through a tap to the main cavity. Vibrations of the bearing on a shake table were measured with two accelerometers, one mounted on the yoke and one mounted on the plunger, and recorded on an oscillograph. The frequency of table vibrations was varied over the 4-15 Hz range in 0.5 Hz steps. The plunger with load weighed invariably 5 kg. The diameter of the 8 mm long throttle through the piston head was varied over the 0.29-10 mm range, this diameter determining the damping ratio. The data have been processed so as to yield the dependence of the transmission ratio (amplitude) at resonance on the intercavity throttle diameter and from this relation, characterized by a sharp dip, the throttle diameter corresponding to the minimum transmission ratio for maximum vibration isolation. Figures 4; references 2: 1 Russian, 1 Western.
[305-2415/5915]

UDC 621.822.6

DEPENDENCE OF ROLLER-BEARING PERFORMANCE ON STIFFNESS OF BEARING HOUSING

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 4, Apr 86 pp 32-35

SOFRONOV, A. Ye., engineer, and IGNATYEVA, Ye. I., candidate of technical sciences

[Abstract] The performance of roller bearings in a rolling mill is evaluated, considering that the bearing housing is not perfectly stiff and the radial load is not sinusoidally distributed over the rollers according to conventional assumptions. The dependence of the bearing performance on the housing stiffness is established by calculation of housing stresses and strains under an array of forces acting on the rollers, the housing being an either integral or

segmental pad. Stiffness of the outer race is added to stiffness of the housing pad, but deformation of the inner race is disregarded. The total clearance in the assembly is the sum of the clearance between shaft and inner race, the clearance between housing and outer race, and the clearances inside the bearing. For this calculation, one symmetrical half of the housing pad cross-section is subdivided into equal sectors by radii intersecting the axes of neighboring rollers, whereupon equations of deformation compatibility in the bearing-housing system are formulated and solved. Theoretical data based on the solution of these equations have been supplemented with experimental data, for a housing pad made of the ED6 low-modulus alloy. There is some discrepancy, large but not exceeding 20% and within the range of maximum load on the rollers. Nevertheless, the results indicate that the load distribution over the rollers is characterized by two maxima and a minimum between them at the center roller. This distribution tends to become more uniform as the stiffness of the housing pad increases and is more uniform under a segmental pad than under an integral one. Maximum and minimum loads depend on the bearing length-to-diameter ratio and the number of active load transmitting rollers decreases with increasing relative radial clearance as well with increasing pad stiffness. The method of analysis and the results have been extended from single-row bearings to multirow bearings. The bearing life has been calculated as a function of the relative radial clearance for an $h_0/R =$ 0.171 ratio of minimum housing pad thickness to bearing radius and as a function of that ratio for zero radial clearance. Figures 4; references 8: all Russian.
[305-2415/5915]

NEW CHEREPOVETS BLAST FURNACE IS OPERATIONAL

Moscow IZVESTIYA in Russian 15 Apr 86 p 2

[Article by P. Novokshonov, IZVESTIYA correspondent: "'Severyanka' Is Smelting Metal!"]

[Text] The Cherepovets Integrated Metallurgy Plant's fifth blast furnace has smelted its first metal. This marks the completion of the first phase in the construction of one of the largest metallurgy units in the world.

Today at a triumphal meeting I. Sokolov, a builder who participated in the construction of all five Cherepovets furnaces, joined his comrades in presenting the metallurgists with a symbolic key to the furnace, a key forged with the labor of the fifteen-thousand-member collective of builders and installers. Hundreds of factories across the country had supplied the construction site with devices and equipment. Dozens of cities had sent their best specialists.

"Severyanka" [Northern Lady] clearly differs, even externally, from the other operational furnaces of the plant. It is a more than 100-meter structure with an unheard-of volume--5,580 cubic meters. The furnace body is welded out of special steel plates with a thickness of 60 millimeters. It is made up of combined sections welded together by semiautomated equipment designed by engineers in the Kiev Institute imeni Paton and VNII Minmontazhspetsstroya SSSR [USSR All-Union Scientific Technical Research Civil Engineering Institute for Specialized Construction and Erection]. The furnace is semiautomated. It has more than 5,500 electric motors alone, with powers ranging from 1 to 32,000 kilowatts!

Despite this equipment, the furnace is fired up the same old way--with firewood--because no one yet has been able to think up a better way to do the job. True, the amount of "kindling" needed is quite impressive--800 cubic meters of choice birch, stockpiled beforehand in northern forests and carefully dried. The furnace will run twenty years from the moment it is fired up until its first major overhaul.

Everything about the furnace is impressive: its appetite--400 carloads of burden per day; its productivity--12,000 tons of metal daily; and its hourly consumption--10,000 cubic meters of water for cooling (however, this river of water is recycled). We should also point out that this giant furnace, destined

by the very nature of its manufacturing process to fill the air with dust and smoke, will actually be one of the most ecologically clean smelters in the country. The furnace is equipped with dust and gas scrubbers, has a pelletizer to convert fluid slag into building material, and has its own electric power station running off the heat and kinetic energy of furnace gas.

Until now, Cherepovets produced three million tons less pig iron than was needed in the plant's open-hearth furnaces, converters, and electric furnaces. Long-distance shipments of metal to compensate for this lack were plagued by frequent delays, disrupting the operation of the many branches of industry where Cherepovets metal was needed. "Severyanka" has completely solved this problem.

The new furnace has reshaped the entire Cherepovets Metallurgy Plant. A railroad station and river port were built to supply the plant with raw material and fuel and to ship off its finished product. The city has built additional housing and a social and cultural center for the metallurgists' collective.

"Severyanka" is operational! But its builders have not left the construction site. They are beginning to build the second-phase installations.

12997/5915
CSO: 1861/363

BRIEFS

CHEREPOVETS BLAST FURNACE OPERATIONAL--Cherepovets (Vologda Oblast)--The largest pig iron smelter in the world--the fifth blast furnace of the Cherepovets Integrated Metallurgy Plant--is in operation. "Severyanka" [Northern Lady] has smelted her first metal. The first start-up complex has been put into operation, with a capacity of 3.5 million tons of pig iron a year. The builders and installers still have a lot of work ahead of them. They have to bring the furnace up to its full rated capacity--4.5 million tons of metal a year. "Severyanka's" first metal shows that the second-phase construction of the entire plant is nearing completion. [Text] [Moscow SELSKAYA ZHIZN in Russian 15 Apr 86 p 1] 12997/5915

MAGNITOGORSK/URALMASH WORK AGREEMENT--Magnitogorsk--Magnitogorsk metallurgists have given the green light to Uralmash [Urals Heavy Machine Building Factory imeni Sergo Ordzhonikidze] orders. All sorts of products for the people of Sverdlovsk are being shipped ahead of schedule. Daily supervision has been instituted to ensure that the accelerated schedule is strictly followed. The collectives of the two Urals industrial giants have reached an agreement to cooperate in accelerating the technical renovation of the Magnitogorsk Integrated Metallurgy Plant. The "Uralmash" collective has pledged to manufacture ahead of schedule units needed in the shops under renovation and equipment needed for the oxygen-converter process being built in Magnitka. The schedule of metal shipments to Sverdlovsk machine builders has been moved ahead by more than a thousand tons since the beginning of the year. This has already resulted in "feedback"--shearing machines have been manufactured for cutting the steel sheet used in the "2350" mill's production line, thereby allowing Magnitogorsk to eliminate a routine bottleneck. [Text] [Moscow SELSKAYA ZHIZN in Russian 15 Apr 86 p 1] 12997/5915

YEREVAN DIAMOND TOOLING--The shops of the Yerevan production union "Almaz" manufacture diamond tools used for machining stone, glass, and metal. At present they produce diamond cutting wheels, segmental trimming wheels, skelp saws, and grinding wheels with various modifications. The factory has begun to manufacture new products--diamond-bearing rolling stock, superfine diamond wheels, and diamond drills. The union's products are in great demand both here and abroad. [Text] [Yerevan KOMMUNIST in Russian 30 Mar 86 p 2] 12997/5915

CSO: 1861/363

IN SCIENTISTS' LABORATORIES: FUEL OF THE FUTURE

Minsk SOVETSKAYA BELORUSSIYA in Russian 22 Mar 86 p 2

[Article by S. Savrasova]

> [Text] Every 15 years the energy needs of mankind double. By the most optimistic calculations there is barely enough of the most valuable energy resources--oil and gas--for one or two more centuries. The scientists of the Belorussian Technological Institute imeni S. M. Kirov have developed scientific principles of a new technology for producing cheap hydrogen, which can be used as an energy source and as raw material for the chemical industry.

"The distinctive feature of our method, developed along with scientists of the Nuclear Energy Institute of the USSR Academy of Sciences imeni I. V. Kurchatov," recounts Doctor of Chemical Sciences and Professor of the Belorussian Technological Institute Georgiy Ivanovich Novikov, "consists of the fact that we are using a nontraditional raw material--hydrogen sulphide gas--for the production of hydrogen." As is well known, the main stake in hydrogen power is allotted to water--its reserves on the Earth are practically inexhaustible. This is a plus. But the minus is the fact that water is one of the stablest compounds in nature. The energy expenditures to separate it into hydrogen and oxygen using the widely known electrolysis is barely compensated by the increase in energy produced as a result of hydrogen combustion. This raises doubts as to the economic advantage of extracting a new kind of fuel in this way.

In contrast to water, the hydrogen atom in the hydrogen sulphide molecule is bound not by the "death grip" of the oxygen atom but by the weak "handshake" of the sulphur atom. It is easier to break these bonds, and the energy costs to produce hydrogen are less. "We have succeeded in establishing the most important conditions under which such processes occur," continues Professor Novikov. "Calculations of the pumping of hydrogen sulphide molecules with additional energy have been performed and confirmed."

It is well known that an electromagnetic field can impart its own energy to a gas, a liquid, or a solid body which has fallen into it. The energy and mobility of the molecules is increased. Under specified conditions one can achieve the effect in which the gas temperature will remain at room temperature

but the internal energy of each molecule will increase so much that the gas is heated to several thousand degrees. And then its molecules disintegrate into the component parts--hydrogen and sulphur. This method has already been used for the solution of this and similar problems at the "Azot" Grodnenskiy Production Association and at the Drogobych Petroleum Processing Plant.

One can't help but dwell on the problems standing in the way of the introduction of this innovation and on the prospects which it opens up. One of the main problems is the limited nature of the hydrogen sulphide reserves, which are, of course, incomparably smaller than those of water. The "glitter" of the method may turn out to be its downfall in the case of a deficiency of industrial reserves of sulphur. However, already it is not so difficult to solve this problem. It has been noted that: the higher the levels from which oil and gas are extracted, the higher is their proportion of sulphur compounds. In some cases up to 25% hydrogen sulphide along with natural gas has been discarded from deep levels. One need only learn how to remove and use it. Then the technology under development will be provided with raw material for many years.

The other component of hydrogen sulphide is sulphur. Today we do not have enough of this valuable product, and it is partly necessary to buy it overseas. By virtue of the production of sulphur the expenditures on production of hydrogen are repaid with interest.

The prospects for the development of hydrogen power are very hopeful. Here are only a few examples of the advantage of using hydrogen. As calculations show, the transporting of this medium for 500--600 kilometers and more is cheaper by a factor of ten than the transmission of electric power over high-voltage lines. A five-percent addition of hydrogen to gasoline raises the efficiency of an internal combustion engine by 20% and reduces the emission of carcinogenic compounds by a factor of ten. The heating value of hydrogen is three times higher and the combustion rate is 64 times greater than kerosene--airplanes using the new fuel will be twice as economical and far lighter than contemporary ones. Using hydrogen in the role of ore recovery, one will be able to discard the ecologically imperfect metallurgical ovens. In them we obtain three tons of steel per day on the average from a one-cubic-meter volume. In hydrogen recovery ovens one will be able to produce up to sixty tons!

This is far from all the blessings that the new glance at a long-familiar element of the Mendeleyev table promises. This hydrogen revolution in technology will occur when mankind breaks the "pre-hydrogen" stereotype of thinking which has become entrenched over the centuries. Actually, the new energy age has already started. It has opened for the scientists of the Belorussian Technological Institute with their work on creation of a unique technology for hydrogen production.

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BRIEFS

CITY OF INDUSTRIAL GIANTS: A PHOTO REPORT FROM SVERDLOVSK--The flagship of our country's heavy machine building--the legendary Uralmash--is rightfully opening up the ranks of the Sverdlovsk giant plants. A hydraulic shovel with a bucket capacity of 20 cubic meters has recently been created here. The design of the ESh-100/125 mobile shovel, unprecedented in size, is being developed now. These figures indicate: a bucket capacity of 100 cubic meters, a boom length of 125 meters. There is also news at the Ural Turbomotor Plant production association. Putting out the PT-140 central heating turbine, the specialists of this enterprise have found a possibility for increasing noticeably the unit's capacity while maintaining its size. Fabrication of equipment for nuclear heat supply stations has begun at Ural Turbomotor. The Sverdlovsk Worsteds Combine experienced great difficulties in the past year with the provision of raw material. But even under these conditions they tried here to do everything to obtain maximum production. The utilization coefficient of production capacities at the combine reached 99.4%. They are preparing here for remodeling [photo not reproduced]. [Text] [Moscow IZVESTIYA in Russian 11 Apr 86 p 1] 8937/5915

COMPUTER CONTROLS TEST STAND--A system of automated remote control of equipment for testing gears has been placed in service at the Orshansk tractor repair plant. It includes a microcomputer with CAMAC equipment and a test stand. In the course of the tests the computer monitors the temperature, rotation rate, and vibration, and it controls the drive motor and generator of the stand. The automated test stand permits obtaining the durability and strength characteristics of the gears and determining their deformation and noise level when rotating. The Orshansk repairers have saved almost 20 thousand rubles by virtue of automation of test stand control. [Text] [Minsk NARODNOYE KHOZYAYSTVO BELORUSSII in Russian No 12, Dec 85 p 10] 8937/5915

ROBOT STACKS PARTS AND SAVES MONEY--The Model AUS robot, which is designed for the oriented collection of coil-type half-races of bearings into stacks, can be used in machine building plants to collect ring-like parts for packing. The robot eliminates manual labor in collection of the half-races and provides high productivity. It has been introduced at GPZ-23 with an economic effect of 12 thousand rubles per year; it has been demonstrated at the VDNKh SSSR (Exhibition of USSR National Economic Achievements). [Text] [Moscow MASHINOSTROITEL in Russian No 3, Mar 86 p 12] 8937/5915

CSO: 1861/361

BUT THERE STILL AREN'T ANY ROTORS...

Moscow IZVESTIYA in Russian 28 Apr 86 p 2

[Article by IZVESTIYA staff correspondent E. Vostrukhov, Riga, and IZVESTIYA special correspondent A. Ivakhnov, Moscow, under the rubric "A Key Task--Putting Technology To Work"]

> [Text] In the resolutions of the 27th CPSU Congress it is emphasized that a characteristic feature of automation in the 12th Five-Year Plan is the rapid development of robot technology, "rotor" and "rotor"/conveyor assembly lines [circular loop structure of workpiece flow], and workplaces with flexible automation. Quite a bit has been written about robots and multitask workplaces, but you can still count on your fingers the number of publications about rotors, just as you can, incidentally, count the number of enterprises where they are now being used. What are the advantages of this type of equipment, and how is it being put to good use?

The Demands of Practical Work

The Riga Latvbytkhim production association puts out humble equipment for everyday chemistry. But it was at this very enterprise, undistinguished in its field, that, a year and a half ago, a seminar took place of managers and specialists of the biggest associations and plants in Latvia, along with Party officials and other high-ranking personnel from many cities and regions. They came to familiarize themselves with the experience of others in automating the most labor-intensive production processes.

A surprising thing was awaiting the guests in a spacious workshop where aerosol spray cans were being produced. The most critical part of this item is the valve. If you hold one of them in the palm of your hand, you will barely feel the weight of it. But it is made up of six parts. As they explained to us, it is difficult to assemble them by hand. And it is even more complicated to teach a machine to do it. As is well known, assembly processes are the hardest of all to automate.

"The demand for aerosol cans has been steadily growing, but to endlessly increase the number of assembly girls was not a possibility," General Director of the Latvbytkhim association V. Solovyanov told us. "There is only one way out--automation of the production. We considered various options, and we decided on this..."

The compact, comparatively small robot mechanisms assemble the critical parts with unusual agility. These surprising mechanisms act with such speed, that for an inexperienced eye to follow the assembly is impossible. Each of them "shoots out" about five hundred valves each minute.

"You have before you some rotor-equipped conveyor assembly lines," Solovyanov explained. "Why did we choose them? On rotor lines and rotor/conveyor lines the assembly process is uninterrupted. There is no waste motion, no stops between intermediate operations. Three assembly lines (of which, during a work shift, only two are ordinarily working while one is in reserve) allow us to free up more than 250 female workers from this task. Labor productivity is increased by a factor of several hundred. Unit cost of the product has gone down by an order of magnitude."

The participants at the Republic-wide seminar convinced themselves with their own eyes of the advantages of the new technology. Since that seminar, a year and a half has gone by. What has been done at the enterprises to apply the experience, so loudly acclaimed, of the Latvbytkhim group? From the point of view of propaganda--a lot. The mass media have recounted in detail the effectiveness of rotor technology. Speeches have been made about it at plenums and sessions of Party committee bureaus. They have conducted several more seminars at Latvbytkhim. Nevertheless, the result of all this propaganda and organizational effort is less than impressive.

The Riga chemists still have only a few followers in their footsteps. At the Daugavpils drive chain plant they have energetically taken on the task of mastering rotor technology. Here, well-thought-out measures are being planned. Integration of the new equipment by stages has been outlined. In the present Five-Year Plan, rotor and rotor/conveyor lines have appeared at the Riga Experimental Plant for Mechanization Resources, at the milking machine plant at Rezekne, and at the Latgales Alus association. Plans are being worked out for their incorporation into the VEF. There are advocates of the new technology at various other enterprises also, but still, alas, without concrete plans of action.

In the republic a scientific-technical program has been worked out for the creation and implementation of flexible computer-integrated manufacturing lines. Rotor technology also has not been forgotten, you might say: it gets a special subprogram. But for the Five-Year Plan they intend to put on-line sixteen lines in all. Out of that number twelve of them are all at that same Latvbytkhim association...

A Living Room Instead of a Workshop

In the capital there is a small plant at which rotor-equipped assembly lines have been working already for fifteen years. It is the Moscow Powder Metallurgy plant of Minavtoprom.

"Life itself compelled us to make use of rotors," said plant director V. Pleshkov. "The plant produces mainly parts for motor vehicles. The field is rapidly developing, the demand for parts is growing. The productivity of the presses which produce the parts has become inadequate. The personnel of the

Central Automotive and Automobile Engine Scientific Research Institute, of the Scientific Research Institute for Technology of the Automobile Industry, and of our plant, have been designing rotor presses, making use of the findings of Academician L. Koshkin, and the NIITavtoprom experimental plant has produced the first prototypes of them."

The robots' principle of action is simple: travelling around in a circle, a mixture of metal and polymer powders successively "makes the rounds" of a set of miniature presses, and, having made a full circle, transforms itself into a finished part. Instead of a workshop with huge equipment, there is an installation of small dimensions. Its "rate of fire" is up to 4500 parts per work shift. One part used to cost fifteen kopeks. Now it costs less than four. Rotor-equipped assembly lines have made it possible to raise the productivity per unit of equipment by a factor of six to eight.

Right now there are eight such robots at the plant. They are producing one-tenth of the plant's entire product line. Located in a small section of a former warehouse--and the warehouse itself is not a particularly spacious hall--the rotor presses are supplying the needs for these parts of several spare parts warehouses and of all the motor vehicle plants in the country.

There is another no less positive side to the introduction of rotors. The introduction of rotor presses has made it possible to qualitatively change the labor of the workers. The former press man has become an operator-adjuster. Here, the human being is not an attachment of the machine, but the boss of the machine.

But in the main workshop of the enterprise, the picture is entirely different. Here the automatic presses do their work. The machines squeeze out blanks for parts from powdered metal. These items must then be placed by hand into metal boxes, be taken away to a firing furnace, and be laid onto a conveyor belt. Here rotor equipment is urgently needed.

Chief technologist of the plant A. Zhulin tells the story:

"The whole question is, who should make such robots. The NIITavtoprom experimental plant has made good rotors, but they only have the means to produce experimental prototypes. The ZIL association has made some outstanding robots, but even for them our requirements didn't fit their scheme of things. A third order was filled by the Saran Technological Equipment Plant, but they also encountered great difficulties. The Saranites had never before had anything to do with hydraulics. They had to turn for help to other plants. They had to make use of other people's test stands."

"Right now, with the help of rotors, we are turning out parts made of metal/plastic mixtures. Here small forces, up to twenty-five [metric] tons, are sufficient. But for forty and above, we are trying to place an order for such rotors right now. To shape parts out of powdered metal, the force in the presses must be up to one hundred tons. It's too bad that there is not a specialized organization that can both design and produce such equipment."

In principle, this should be the concern of Minstankoprom. But in that Ministry they have no desire to take on extra tasks. For this reason all the interested parties are still working with primitive technology.

If each concern keeps on designing and building rotors on the principle of "we do only what we do best," how much money will be spent in vain?...

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FOUNDRY DIRECTOR CRITICIZES CASTING MACHINERY DESIGNERS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 13 May 86

[Article by V. Dunayev, director of Tsentrolit plant, Sumy: "Two Steps Backward"]

[Text] In industry there is probably no manufacturing activity which has a greater requirement for mechanization and automation than foundry practice. Since olden times manual labor has prevailed, with high levels of dust and noise. To a great extent, this may also be said about our plant, the Tsentrolit. Especially now, when the design capacity has been exceeded and some equipment is worn out and obsolete. Working under great pressure, the collective is still keeping up with the state plan, managing to work at a profit. Last year alone a profit of more than six million rubles was shown. However, the need to retool is standing at the door and refuses to go away. Without retooling there can be no growth in labor productivity or satisfaction of increasing requirements for quality of complex castings produced by the plant.

It would seem that a material base for retooling exists. The NPO VNIIlitmash [Scientific Production Association of the All-Union Scientific Research Institute for Casting Machinery] and the VPO Soyuzlitmash of Minstankoprom [Ministry of the Machine Tool and Instrument Building Industry] recently offered foundry workers a wide range of machinery and equipment, including automatic molding lines. We acquired one of these lines at the Ivano-Frankovo Avtolitmash plant, which recently combined with the Karpatpressmash association. We acquired it to replace the old jolt-ramming casting conveyor. Although the price was not small--1.7 million rubles--the expected savings were to be considerable: the designers and manufacturers promised an hourly output of almost twice that of the old conveyor.

It is easy to see why our specialists and laborers were filled with enthusiasm when they undertook installation of the new equipment. However, the enthusiasm soon turned into disappointment and then into indignation. Practically none of the parts were as shown in the drawings. Many assemblies had to be redesigned. The line was put together and finally made to operate. However, the most that could be attained was half of the output specified in the certificate. That is less than the old conveyor produced. Also, after operating for one month the new equipment literally started to fall apart before our eyes.

Only after several telegrams were sent to the Minstankoprom did V. Shvartsman, chief designer of the Ivano-Frankovo Special Design Bureau (SDB) for automatic casting lines, appear at the plant. After listening to the complaints calmly, he signed a joint statement relative to the need for thorough redesign of 17 assemblies and mechanisms. Then he left on that note. He felt that there was nothing he could do in a situation where the originator of the design was the chief institute of NPO VNIILitmash, and the Special Design Bureau was only there to "update" the product.

Soon thereafter we received information to the effect that none of the serially-produced molding lines of the given model were capable of more than half the rated output. This scandalous matter was not particularly disturbing to the NPO VNIILitmash, the SDB or the manufacturer. It was not disturbing because this was not the first time they had put out such "masterpieces".

The situation was much worse in the case of Model 22411 molding machines purchased from the same Avtolitmash. According to the certificate accompanying the machines, they were supposed to increase the output 2 to 2.5 times compared to the machines then in use. However, SDB and Avtolitmash specialists wasted three years attempting to make the machines functional. They are gathering dust in the shop awaiting assignment to scrap.

When one reflects on how much effort, resources and time are spent on such new items, one starts to feel acutely how wastefully we manage. It is difficult to understand the paradox of the reduction in quality and reliability of new casting equipment, the absence of productivity improvement and the dizzying price increase.

The old casting conveyor with three molding machines in use at the plant cost 141,000 rubles. The new automatic molding line is inferior to the conveyor in output and quality, but it costs 12 (!) times more. A couple of 234M molding machines cost 27,000 rubles. They were replaced by new ones, model 22411, with a price tag of 195,000 rubles. However, the replacement turned out to be inoperative. A good molding machine, the 232M costing 3,925 rubles, was produced in Pavlograd. The design was modernized and manufacturing responsibility transferred to another enterprise. The output remained the same, the quality of the manufactured product was inferior, but the price nevertheless rose to 9,027 rubles.

The big question here is: How do these monsters of technology come about? A favorable climate for them is the low level of design work of NPO VNIILitmash. I cannot understand how it is possible to produce an automatic line which has an output lower than that of a piece of obsolescent general-purpose equipment. But this is what happened! With the certainty that the consumer, having no alternative, will accept it. Accept it he must, and redesign it himself too, and by doing so making life easier for the poor performer.

Without justifying the plant operators producing this junk, it would be desirable to have a look at the role of the developer and fashion designer for casting equipment--the VNIILitmash. How does the NPO exercise control over the realization of its concepts? What ties bind it to the manufacturers and consumers of new items?

We have become convinced that the creators of the new casting machines and automatic lines are more concerned with superficialities than with the effectiveness of their designs. NPO VNIIlitmash transfers technical documentation for series production of new machines and lines to the manufacturers, where the local Special Design Bureau adapts the design to the capabilities of their facilities. There is no monitoring of production quality by manufacturers, and they do not perform equipment assembly or testing--not even dry runs. The institutes, SDB's and plants simply have no designer's supervision.

When one looks for those responsible for producing this junk, the institutes point toward the SDB's, implying that the latter altered the drawings. The SDB's always come up with a retort--mistakes in design. And there is no end to useless arguments.

The way the VNIIlitmash approaches coordination with production personnel of and by itself gives an indication that something is wrong. When Tsentrolit specialists request representatives of the head institute to help resolve a problem, the latter do not refuse but immediately impose a condition: "put your signature" on a particular savings figure and we will work with you. In other words, instead of receiving help we are asked to provide a savings figure, even one that exists only on paper. In our opinion, this approach is incompatible with the intent of the 27th CPSU Congress to bring about rapid acceleration in scientific and technical progress.

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THE COMPUTER BRINGS ORDER TO A BEARING WAREHOUSE

Moscow MATERIALNO-TEKHNICHESKOYE SNABZHENIYE in Russian No 3, Mar 86

[Article by L. Danilov, chief mechanic of the Cherepovets Combine imeni Fiftieth Anniversary of October, Ye. Belov, bureau chief, A. Gerasimenko, senior engineer at the information computing center, and A. Freydlin. VNIImekhchermet sector director, under the rubric: "Labor Efficiency and Quality"]

[Text] The central warehouse for bearings and rubberized parts at the Cherepovets Metallurgical Combine, with an area of more than 1300 square meters, has been in existence already for more than 20 years. It is comprised of storage facility for bearings of all type sizes and rubberized parts, and a bearing rustproofing facility. It is equipped with an electric traveling crane having a 10 ton load capacity and possesses railway and truck entrances.

The bearing storage facility is divided into two sections. In one of them, miniature bearings provided with tags indicating the bearing number are stored in rack compartments. In the other large-scale roller bearings and film lubrication bearings lie in special containers. Cards indicating the number of the bearing, the rustproofing date and its location are inserted into special pockets in each container.

Inspections are periodically conducted to optimize the arrangement of the products and to free up floor space. A specific humidity and air temperature are maintained within the storage room. The air temperature must not drop below 18 degrees Celsius, otherwise the corrosion-preventing compound crystallizes and moisture penetrates into the cracks that form.

Elevator racks were constructed for small, mass-produced bearings. One need only switch on the elevator, move the required compartment into position and extract the bearing. The racks and containers are produced from lightweight roll-formed sections painted in light, placid hues. This is all in keeping with the requirements of modern industrial aesthetics. The production shops retain only small emergency supplies of bearings, upon which demand limits have been placed that depend on the condition of the shop equipment.

The centralized acquisition of individual types of bearings is hindered by the fact that the increase in production capacity of the enterprise that produce these bearings is lagging behind the growth in industrial demand for them.

Improving the system that accomplishes the planning, accounting and distribution of the bearings to repair and maintenance needs and that regulates the warehouse stock has become an urgent task under these conditions.

The operating conditions of metallurgical combine manufacturing equipment and the frequency of product deliveries to the central warehouse require the effective monitoring of the movements, consumption and availability of these products. Considering the extensive products list (more than 2,000 different items), it is extremely difficult to accomplish such monitoring when data is manually processed. Workers of corresponding subdivisions have been forced to rely only on registration books, as a result of which the proper monitoring of yearly requisitions and stored product availability is not provided and the analysis of product consumption and warehouse stock management is hindered.

An accounting-information system based on the YeS 1022 computer has been developed and introduced at the Combine in order to eliminate the mentioned faults. The system software supports the automated calculation of the yearly demand for bearings and rubberized parts within the products list for repair and maintenance needs of the Combine, the automated accounting of product and bearing consumption of the Combine's shops for orders executed in the department of the chief mechanic, and the purposeful analysis and monitoring of the utilization of products in the manufacturing equipment of the Combine. The accounting-information system was designed on the basis of an analysis of existing office procedures with the goal of the economic use of the bearings through their optimal distribution among consumers.

Output document forms have also been developed and their optimal distribution frequency has been established. Thus, a summary list of bearing deliveries for maintenance (issued twice weekly) contains data about the designation of a bearing, the number of bearings requisitioned by a shop for the year with production figures relative to the start of the year, and data about their availability in the warehouse and order completion requirements. These bearings have priority in delivery.

The extra-requirement form (issued once every ten days or when needed) contains the designation of the bearing, number remaining in the warehouse, and the number of bearings required to complete an order. The bearing demand accounting list (since the start of the year) for a given shop (issued quarterly or when needed) contains the bearing number, their number in the yearly requisition and the number produced since the start of the year for maintenance and for orders. The bearing order completion accounting list (issued twice yearly) contains the order number, the bearing number and the number of bearings requested by an order.

The input (source) documents consist of the estimated yearly roller bearing need requisition and the complete list for orders, acceptance certificates and demand. The input documents are received by the bearing sector of the department of the chief mechanic.

After the decision is made to ship the bearings, the updated and signed summary lists are sent to the bearing warehouse. After the list is marked to indicate the shipment of a bearing to the consumer, the list is sent to the computing center in order to update the appropriate files.

The accounting-information system utilizes a number of data processing algorithms. The computer selects a particular algorithm in dependence on the input document format or type of request. Data regarding the product list and quantity of bearings required to fill all orders handled by the Combine for non-standard equipment, new equipment, overhaul and routine repair, optimization, cooperative deliveries, etc., were refined during the implementation of the accounting-information system. The monthly accountability of shops before the department of the chief mechanic for the movement and surplus bearings left in shop warehouses and store rooms was introduced. An instruction for document completion and the procedure for receiving bearings from the central warehouse was developed in order to create clearly defined interrelations between the shops, the department of the chief mechanic and the accounts department of the Combine.

The creation of a centralized warehouse for bearings and rubberized parts that utilizes a computer for the inventory control and distribution of the bearings can help diminish irreducible stocks of similar objects which are used in the equipment of different shops, reduce the demand for these objects in the Combine by cancelling unnecessary requisitions, ship objects in accordance with approved requisitions, justify yearly plant requisitions with the results of analyzing the demand for objects over the course of several years, determine the optimal inventory of such objects, and also accelerate shipment of the objects.

It should be noted that we have achieved a maximal degree of production equipment readiness and have completely eliminated unintentional downtime resulting from bearing shortages, mechanized loading-unloading operations, cut the number of equipment attendants, reduced storage costs, and reduced consumption of the bearings.

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SELECTED SYNOPSES OF ARTICLES IN MASHINOVEDENIYE No 2 MAR-APR 86

Moscow MASHINOVEDENIYE in Russian No 2, Mar-Apr 86 pp 109-112

UDC 621.9

MODELING THE STRUCTURE OF AN AUTOMATIC SEQUENTIAL-OPERATION MULTI-STATION MACHINE SYSTEM

[Synopsis of article by A. M. Tsarev and S. V. Ul'yanov, pp 12-20]

[Text] The problems of modeling the structure of a multilevel multi-station machine system for machining operations are examined. The problem of determining the structure of the multi-station machine system and the product machining process is reduced to the formulation of a machining sequence in a set of processes within component allowances, that must be distributed among the stations on various levels of the hierarchy by multilevel distribution of stations along the sequence. Illustrations: 4; tables: 2; bibliography: 4 titles.

UDC 621-52

OPTIMUM CONTROL IN RESONANT MANIPULATOR SYSTEMS

[Synopsis of article by V. I. Babitskiy and A. S. Kovaleva, pp 21-25]

[Text] Optimum control principles in resonance electric drive manipulator systems providing maximum manipulator speed are investigated. The variability of the weights of the mobile portions on both the forward and return pass is accounted for, together with the lag of the transient processes in the motor and permissible approach speeds to the stops. An averaging scheme together with a maximum principle were used to solve this problem. Computation relations are derived for synthesizing optimum control. Optimum control principles are given for the motor together with corresponding motion principles of the actuator mechanisms in the manipulator. Illustrations: 4; bibliography: 7 titles.

UDC 621-503

SOFTWARE PACKAGE FOR DEVELOPING AN ANALYTICAL MODEL OF AN INDUSTRIAL ROBOT

[Synopsis of article by M. Vukobratovich and N. Kirchanski, pp 26-30]

[Text] A new algorithm used as the basis for a software package designed for use in a microcomputer to generate nonlinear or linearized models of a manipulator is discussed together with sensitivity models. The software package modules are examined; these include the input-output module, generation of the dynamic model, time-optimization of model generation and model output in real time in the microcomputer language. The use of the package is illustrated using an anthropomorphic manipulator as an example. Figures 1, tables 2, references 9.

UDC 531.384.394.44

MOTION OF A SOLID ALONG AN OSCILLATING TUBE WITH TRANSVERSE WALL PLIABILITY

[Synopsis of article by G. Ya. Panovko, pp 31-36]

[Text] The motion of a solid along an inclined tube experiencing two-component harmonic oscillations is investigated when the frequency of the longitudinal oscillations of the tube is twice the frequency of its transverse oscillations. Unlike R. M. Brumberg's well-known formulation, the transverse pliability of the tube walls is accounted for, together with the nonlinear dependence of the friction coefficient on the slip velocity of the solid. It was discovered that with "transverse" resonance, the average velocity of the body is significantly higher with the same excitation parameters. The computation results are given as a graph plotting the dependence of the dimensionless transport velocity as a function of the dimensionless transverse vibration parameter and elastic pliability parameter of the tube walls. The role of possible tension is analyzed. Illustrations: 6; bibliography: 4 titles.

UDC 621.01:531.391.5

THE STABILITY OF STEADY-STATE MOTION OF A MACHINE SET WITH A HORIZONTAL ROTOR MATERIALS-HANDLING MACHINE WITH VARIABLE PARAMETERS

[Synopsis of article by Yu. V. Naumenko, pp 36-41]

[Text] The quasistatic mechanical characteristics and moment of inertia relations of liquid and bulk processed material, which are functions of the rotating speed, are given; these were derived numerically for a horizontal rotor with variable parameters whose variability results from the relative motion of a deformed solid in a circular cylindrical cavity. Asymptotic stability conditions are derived for the steady-state motion of the associated machine set. It is demonstrated that variations in the moment of inertia of the material influence the stability of motion of the set. Qualitative parameters of the quasistatic mechanical characteristics of the motor that provide operational stability of the set are determined for various material transport conditions. Illustrations: 3; bibliography: 12 titles.

UDC 621-877

A POSITIONAL PNEUMATIC LINEAR DISPLACEMENT DRIVE

[Synopsis of article by G. V. Kreynin, L. I. Krivts, K. S. Solntseva, V. Frank and A. Ulbrikht, pp 42-48]

[Text] Two approaches are considered to designing a pneumatic positional drive: using a mechanical brake employing pneumatics to provide preliminary speed reduction and a control system with a servodistributor operating in a pulse-width condition. Data are given on the designs of various units as well as the drive structure and control system; specific experimentally derived dynamic precision and speed characteristics are obtained for both cases. The problem of selecting the primary parameters of a pneumatic positional drive is discussed. Illustrations: 8; tables: 1; bibliography: 7 titles.

UDC 621.226

A HYDRAULIC SERVODRIVE FOR AUTOMATIC SYSTEMS

[Synopsis of article by Yu. V. Peresadko, pp 49-53]

[Text] Hydraulic servodrives with speed correction are examined; these are particularly effective in application to automatic high precision manufacturing sets. The tracking accuracy of such drives under low loads is improved by several orders of magnitude. A method is given for analyzing a correcting device together with the statistical characteristics of the drive overall. Data are given from experimental studies of this drive; these data are consistent with theoretical conclusions. Illustrations: 4; bibliography: 3 titles.

UDC 531.391.1

ROLLING THEORY FOR APPLICATION TO A CLOSED FLEXIBLE STRING

[Synopsis of article by A. I. Dobrolyubov, pp 54-60]

[Text] The motion kinematics of a stretchless flexible string that forms a closed, noncircular loop experiencing undulating motion and interacting with a cylindrical support surface are examined. Analytical expressions are found on the basis of an interpretation of wave motion as the sum of the relative tangential and translational rotation motion for the velocities and displacements as well as the trajectories of points for various cases of wave motion. The application of these results to kinematic computations of continuous and step-type mechanisms is demonstrated. Illustrations: 5; bibliography: 5 titles.

UDC 621.01

THE FIVE-PARAMETER OPTIMUM DESIGN OF A PLANAR LEVER-TYPE FOUR BAR SLIDE LINKAGE WITH ACCELERATED REVERSE

[Synopsis of article by Nguen Chuong, pp 61-65]

[Text] The optimum design of a planar lever-type four bar slide linkage is examined. The variability in the idle speed of the mechanism, i.e., the ratio of the idle interval to the operate cycle interval, is used as the efficiency function. The optimization parameters include the dimensions of the bars in the linkage; five such bars are used. The problem of minimizing the efficiency function with constraints on the optimization parameters is posed. Routines for finding optimum parameter values are obtained. A numerical example is given. Illustrations: 2; bibliography: 5 titles.

UDC 539.4

A METHOD OF COMPUTING THE SERVICE LIFE OF THE PRIMARY COMPONENTS IN PIPELINE SYSTEMS UNDER LOW-TEMPERATURE, LOW-CYCLE LOADING

[Synopsis of article by A. P. Gusenkov, O. Yu. Tikhonova, pp 66-75]

[Text] A standard example of structural elements in which concentration and membrane zones exist and in which loading conditions result in the accumulation of fatigue and quasistatic failures is used as the basis for a computation analysis of long-term low-cycle strength. A shell design with flanges is used as the model element; such a design simulates the primary components in a pipeline system under repeated internal pressure loading at high temperatures. The kinetics of the stress-strain state and the service life are both investigated as a function of the geometry of the structural element, the time exposed to the loading, the level of operating temperatures and the nominal loads. Based on the strain-kinetic criteria of long-term low-cycle strength, the kinetics of failure accumulation in the membrane zone and concentration zone are computed and the failure site is determined. The promise of these approaches for estimating the long-term low-cycle strength of structural elements is demonstrated. Illustrations: 5; tables: 4; bibliography: 9 titles.

UDC 531.252.3

COMPUTATIONAL-EXPERIMENTAL METHODS IN ELASTIC BODY MECHANICS

[Synopsis of article by A. K. Preiss, A. V. Fotin, pp 76-83]

[Text] Computational-experimental methods of investigating the stressed state of machine and structural components are examined. In these methods, the measurement results are utilized in generating boundary conditions that may be determined for either the entire surface or a portion of the surface of the test object, depending on the experimental method used as well as the structural and operational conditions. A formulation and methods for solving the problems of recovering the parameters of the stressed state in the body or in

surface areas inaccessible to direct measurement are given for application to these conditions. A brief survey of the primary studies devoted to the development and application of computation-experimental methods is given. Bibliography: 18 titles.

UDC 539.43

FAULT ACCUMULATION AND BREAKDOWN CONDITIONS OF MATERIALS UNDER THERMOCYCLIC LOADING

[Synopsis of article by R. A. Dul'nev, pp 84-90]

[Text] Criterional equations of low-cycle nonisothermic fatigue that include material plasticity as the primary parameter must account for the history of loading of the material. This is particularly important for materials with a nonmonotonic relation between the plasticity and temperature (nickel-based heat resistant alloys) in a range typical of nonsteady-state loading of machinery parts. For such steels used in manufacturing the critical components of gas turbine engines (turbine blades and disks) the plasticity conditions are determined under loading achieved in the first operational cycle: with reversals in strain and temperature changes from the minimum temperature to the maximum temperature and back again. The derived plasticity characteristics were 20-40% below standard characteristics. Accounting for this fact in computing cyclic failures makes it possible to obtain better convergence between computed and experimental service life values than using other methods of computing failure. Illustrations: 5; tables: 2; bibliography: 13 titles.

UDC 621.643.44-762

SIMULATION OF THE SEALING OF FLAT JOINTS

[Synopsis of article by V. P. Tikhomirov, L. V. Volper, O. A. Gorlenko pp 91-94]

[Text] A method and algorithm for simulating the seal of flat joints are examined; the algorithm is based on a statistical test method (the Monte Carlo method). During the construction stage of the sealing components, it is possible to determine the critical convergence of conjugate surfaces at which the joint seal is provided (the industrial method of machining the working surfaces of the joints and the highest points of their surfaces are accounted for). Results are given from the experimental testing of computed values for the critical convergence. Illustrations: 3, bibliography: 11 titles.

UDC 621-387

AUTOMATIC BALANCING OF THE ROTOR IN A MULTIMASS SYSTEM BY MEANS OF A SPHERICAL STACKED AUTOBALANCE

[Synopsis of article by V. I. Kravchenko, pp 95-99]

[Text] The problem of balancing the rotor in a multimass system by means of a spherical stacked automatic balancing device is examined. A method is given

for solving the problem; the application of this method is illustrated by the important practical case of a dual-mass system. The conditions that provide balancing are defined. Experimental data are given. Figures 3, references 11.

UDC 620.178.154.56

THE TEMPERATURE AND TEMPORAL RELATIONS OF STRUCTURAL MATERIAL HARDNESS

[Synopsis of article by V. V. Izmaylov, A. F. Gusev, pp 100-104]

[Text] Theoretical formulae are derived for the temperature and temporal hardness relations based on thermal fluctuation strength and strain theory using a model of a solid in the form of a linear atomic chain. The coefficients in this formulae are expressed in terms of the physical constants of the materials. The theoretical relations are confirmed by experimental results obtained from the literature and by the authors. Illustrations: 3; bibliography: 19 titles.

12576/5915
CSO: 1861/342

NEW PRODUCTS SURVEYED

Moscow TEKHNIKA I NAUKA in Russian No 2, Feb 86 p 20

[Article under the "Short Comments" rubric]

[Text] At the Brovary Powder Metallurgy Plant (255020 Brovary, Kiev Oblast), they have started producing porous plain bearings. The economic effect from the replacement of 1 ton of bronze bearings, bushings and inserts is 4,200 rubles. Antifriction items are also being produced from special powder compositions: iron - graphite - copper - sulfur which are 15-23 percent porous. After sintering and calibration the free internal volumes are filled with oil or other lubricants, including synthetic ones. The new bearings work under heavy conditions considerably longer than traditional ones. The maximum operating temperature is 100 C. Another valuable quality is their good adaptability to various equipment, as powder metallurgy items are easily turned on a lathe, drilled and ground.

The Ileksa Ultrasound Phasometer is a promising development by the Leningrad Polytechnic Institute (195251, Leningrad, Politekhnicheskaya Ul. 29, Kafedra "Avtomaty i Poluavtomaty"). The electronic instrument, which has already been introduced at two enterprises, had an annual economic effect of more than 100,000 rubles. Its main task is the measurement of industrial ultrasound emitters, their mechanical impedance and phase distortions. Another feature is the automatic regulation of the amplitude magnitudes. The frequency range is from 18 to 80 kHz. Two outputs are planned analog (for recording) and digital (for calculating phase angles and transmission of information to a computer). The Ileksa optimizes the work programs of ultrasound systems.

The "Stikar" electrocardiostimulator is an example of successful joint work by Moscow medical specialists and engineers at the Electronics Department of MIFI [Moscow Engineering-Physics Institute]. The instrument, generating programmed pulses, regulates the frequency of cardiac contractions. It is highly accurate in maintaining a given frequency of muscle pulsation. There are provisions for protection from accidental short circuit and high voltage transients. The automatic control system checks the instrument and its batteries. The stimulation does not cease even when the batteries are being replaced. To acquire this apparatus, write: 101805, Moscow, Krivokolennyy Per., 12, Soyuzmedtekhnika.

Spraying a solid product as a liquid is an original technology proposed by engineers at the NIIkhimmash [Scientific Research Institute for Chemical

Machinery] (Moscow, B. Novodmitriyevskaya, 14). An atomizing injector was developed in which powder mixtures are converted into a pulp with a strictly determined water content. This injector is connected to a drying apparatus. Air, heated to higher temperatures than previously, is blown through tangentally arranged openings. This improve's the device's productivity. This unit produces complex pelleted fertilizers, eliminating dust wear of valuable components. Such attachments can also be used in the food, pharmaceutical and other industries. The annual economic effect from one unit is 135,000 rubles.

NEW INSULATORS FOR ALUMINUM ELECTROLYZERSS

[Article by G. Malinich, under the "Arsenal for the Designer and Technologist" rubric: "260 Times More Effective"]

[Text] Plant technologists' orders can sometimes only be filled by a nonstandard approach. For example, an aluminum plant needed insulators to improve electrolyzer reliability.

Novosibirsk scientists and engineers undertook this work. They didn't waste any time on the improvement of known designs. They created a fundamentally new metal ceramic device for insulating the anode and cathode components of the electrolyzer when the crust is forced through prior to loading with alumina. The insulators must work in a very corrosive environment. Specialists at the Siberian Department of the USSR Academy of Sciences proposed a three layer composition: steel tube - ceramic layer of aluminum oxide and carbide - and a central steel pin. All these are combined into a monolithic unit by the energy of a directed microexplosion. The impulse binds the powder so that no subsequent sintering is needed. The layer is strong, withstands high temperatures, and guarantees reliable insulation (its electrical resistance is 1 Megaohm). Its service life is increased from 1 week to 5 years over traditional insulators. The annual economic effect from non-stop operation is 388,000 rubles.

This item was invented at the Institute of Hydrodynamics imeni M. A. Lavrentyev -- the originator of contemporary explosion technology. Its scientists have created a range of highly ececctive methods for welding and sintering by explosion. These are useful in various sectors of the national economy.

Send requests to: 630090, Novosibirsk-90, prospekt Akademika Lavrentyev, 15

11574
CSO: 1861/300

USE OF LASERS IN METALLURGY OUTLINED

Moscow TEKHNIKA I NAUKA in Russian No 2, Feb 86 pp 28-30

[Article by M. Orlova, journalist: "The Birth of Laser Metallurgy"]

[Text] Developments by scientists at the Institute for Metallurgy imeni A. A. Baykov laid the basis for a new direction in technology -- laser metallurgy. If a laser beam is directed to a piece of metal in a high pressure gas medium, a plasma forms which actively reacts with the metal, melting in in the area hit by the beam. This forms a surface layer, increasing, by 4-5 fold, the metal's corrosion resistance, hardness and wear resistance.

Much has already been said about lasers and their practical applications. When there is new information about how, with the help of lasers, metal is cut, tunnels are accurately driven, etc. this means that an organization has found a solution to another specific problem. Now we are talking about a large, promising development by scientists at the Institute for Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, which lays the basis for a new direction in technology -- laser metallurgy.

Aleskandr Alesksyevich Uglov, doctor of technical sciences and chief of the Laser Metallurgy Laboratory, explains: "This began 12 years ago. Prior to that, most of our, and other scientific organizations' work involved the study of the effect of laser radiation upon metals, alloys, semiconductors and dielectrics in ordinary condtions (in the air) or at reduced pressures. There were studies of the possibility of welding, burning and other technological operations. In 1972 we first became interested in the behavior of materials subjected to lasers while in an gaseous medium at increased pressure -- from 10 to 200 atmospheres. The idea arose -- would the gas "mix" with the metal under these conditions.

At the laboratory they build a chamber in the form of a metal cylinder with thick glass windows. A target sample and lenses focusing the laser beam were installed in the chamber. Both solid state and gas lasers were used. The first was pulsed and the second (CO_2) continuous.

A series of experiments began in which the gas pressure and irradiation conditions varied.

It turned out that when the laser energy density reached $10^6/cm^2$, there were only insignificant "burns" on the target surface, while under similar conditions in ordinary air, holes were formed in the metal. If energy density was increased $10^7/cm^2$, then a previously undiscovered phenomenon--plasmoids--appeared in the layer of gas penetrated by the laser beam.

The plasma thus formed, irradiated with high density energy, and the surrounding gas cloud form a complex system, the study of which is continuing. However, the following has been explained. The plasma cloud is not stationary, it can shift along the laser beam. The speed of movement depends upon the energy of laser radiation. The more powerful it is the quicker the cloud moves from the target; while the greater the energy loss, the lower the density of the energy falling on the surface of the part being worked. However, if one creates conditions for confining the plasma in dynamic equilibrium near the sample's surface, then one can cause it to very effectively interact with the metal.

What takes place here? The plasma cloud includes gas, which is subjected to the effects of the laser and is in a molecular, monoatomic, ionized and energized state. Compounds are actively synthesized on the sample surface: the smelting effect of the laser beam causes the metal to "greedily" absorb energized and charged gas particles from the plasma. After the laser is turned off the molten material crystalizes and upon the metal surface a thin layer forms which is qualitatively different from the original material. If nitrogen is used as the gaseous medium, then this layer consists of nitrides of the metals in the sample-alloy being worked. If a carbon containing gas is used, then carbides of these metals are formed.

The nitride or carbide layer gives the part hardness, corrosion resistance and other valuable properties.

Thus, by changing gas composition and radiation parameters, one can obtain different structures of surface layers of a given thickness and with given properties on the same sample. This means that any metal part can be given the needed properties.

Scientists came to the conclusion that they had a fundamentally new technology -- laser-plasma. With it, one can strengthen those areas of a part which are subjected to the most wear. The small size of the strengthened area makes it possible to more completely use the part's dynamic strength. With traditional hardening processes, in most cases the surface microhardness of the entire part is increased, this increases its brittleness and reduces its ability to resist mechanical action. Also, it is possible that the laser will "correct" defects from previous machining.

Local strengthening also has another advantage: one can process parts with complex configurations and inaccessible sections.

In 1979 associates at the Laser Metallurgy Laboratory were awarded a USSR State Prize for their work on laser heat treatment in the radio-engineering industry.

The most promising areas for using laser-plasma treatment of metals have already been determined.

Here is an example. According to the Ministry of the Medical Industry, medical institutions' demand for medical instruments cannot always be completely met. It is not only because not enough instruments are made, but also because they wear out too soon. A suturing needle only lasts one operation, as it is in a very agressive environment -- blood, lymph, etc., which breaks down even high alloy steel. Laser hardening opens a way substantially extend the service life of medical, especially surgical, instruments. Already the annual economic effect from its introduction at the Medinstrument NPO [Scientific Production Association] in Kazan exceeds 1 million rubles.

Hardening bearings is another example. The widespread introduction of the technique into mass production is still in the future. However, proof of its efficiency has been obtained: testing, jointly with the All-Union Scientific Research Institute for Drilling Equipment, of bearings for drill rigs. After processing by laser they worked 10-15 fold longer than unprocessed, series produced bearings. It is easy to imagine the prospects opened if drilling speeds are increased and there are savings in alloy steels from which these bearings are made.

At the Order of USSR Selkhoztekhnika, the IMET imeni A. A. Baykov is hardening and repairing agricultural machinery parts with the help of laser processing, in particular the laser smelting of metal powders. The problem is that in a number of cases the gas-thermal method of coating metals is not sufficiently effective. It requires the selection of a pair of materials -- a coating powder and the initial matrix. The matrix is prepared by cleaning and polishing. Gas-thermal treatment does not always assure high adhesion of the powder, especially if these two conditions are not met.

These shortcomings are eliminated by laser processing, which can be not only an independent technological process, but also an additional completion stage of the gas-thermal method. The laser beam, smelting the surface, eliminates pores and increases the layer's adhesion. The material's surface becomes more monolithic and stronger.

Thanks to the possibility of flexibly using gaseous media to obtain various types of structure, the laser technology will not be less, if not more, efficient than the present methods using electron beam technology.

Thus, laser metallurgy is a waste free, highly productive technology with a small number of operations. An additional plus is that it is a low energy process. This latter requires explanation. A laser consumes large amounts of energy. The efficiency factor for the transformation of electrical energy into monochromatic radiation is not great: 1-2 percent for solid state lasers, 15-20 percent for a CO_2 laser. However, in our case, the total efficiency for the laser processing unit is higher than that of traditional methods for coating

and hardening metals. The energy advantage is the result of high radiation concentration and flux density. Lasers make it possible to avoid loses -- heat is not used to warm up large amounts of material.

Another advantage is the simplicity of using lasers compared to electron beam units. Recall, that for the latter a vacuum is needed and personnel must be protected from dangerous X-rays.

In short, laser technology opens a new page in metallurgy -- both in scientific research and production.

11574
CSO: 1861/300

UDC 61.762.06

MODEL DA1022 AUTOMATIC MACHINE FOR MOLDING MAGNETS FROM OXIDE POWDERS

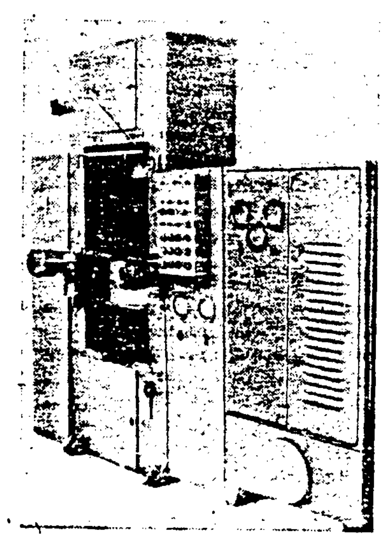
Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 1, Jan 86 pp 10-11

[Article by V. I. Yelkin and O. M. Zmeyeva]

[Text] A special automatic hydraulic machine with force of 160 kN for molding magnets from oxide powders model DA1022 has been developed and manufactured.

The automatic machine is designed to manufacture anisotropic magnets for high-torque electric motors of NC machine tools, ring magnets for loudspeakers, magnets for household equipment and so on.

The automatic machine is a column-type vertical press mold with automatic pouring of powder into the die, two-sided molding due to floating of the die and pushing the finished products onto a conveyor (see figure). The frame of the automatic machine is a column type, to the upper crosspiece of which is built in an upper cylinder and into the bottom crosspiece of which is built in a lower cylinder. Pipelines, final switch mechanisms and electric communication lines are located to the frame.



The upper tool unit, press mold block and magnetic system unit are located in the die-forging space of the automatic machine. A feeder with hopper is installed on the die plate of the press mold block.

A conveyor to move and store the molded blanks is installed on the front side of the automatic machine on the columns of the frame.

A hydraulic assembly abuts against the automaton through a panel and consists of a hydraulic station, panels of the pumping unit of the hydraulic assembly and pressure gauge unit.

A suspended control console is attached to the upper part of the panel.

The main electric equipment of the automatic machine is located in a separate electric cabinet and it is installed under supervision of the user in a location convenient for servicing.

Specifications of Model DA1022 Automatic Machine

Rated force, kN	160
Rated pressure of working fluid, MPa	20
Stroke of upper cylinder plate, mm	200
Force of lower cylinder (downward course, contraction), kN	56
Filled height of powder, mm	63
Regulation of filled height, mm	6-63
Largest size of product in layout, mm	50
Holding under pressure, s	0-60
Diameter of die, mm	160
Dimensions of coil of magnetic system, mm	700 × 300 × 270
Speed of upper cylinder plate, mm:	
no load stroke downward	124
press molding	2-17.6
reverse stroke upward	324
Dimensions of table, mm:	
length	440
width	200
Distance between table and upper cylinder plate in its topmost position, mm	786
Overall dimensions of automatic machine (without electric cabinet), mm:	
from left to right	2,390
from front to back	1,515
height	2,360
Mass, t	2.9
Total power of electric motors, kW	8.62

The upper tool is attached by flanges to the plate, which is in turn secured to the upper cylinder plate by racks.

The press mold block is used to install lower tools on it that shape the article. A block for press molding to ring-type articles is available in the automatic machine.

The table of the press mold block on racks is installed on the bottom crosspiece of the frame. The racks, which are used to install lower fixed male dies, are installed and secured by flanges to the table.

The sleeve of the block on racks is installed on the bottom cylinder plate and it is attached through the bore by screws with the plate that carries the interchangeable and tool dies. The male dies, which form openings in the articles, are secured by screws to beams attached by screws to the sleeve. The screws are regulated in height for installation of the male dies at the same level with the tool die.

The magnetic system consists of two coils, one of which encloses the female die and is attached to the sleeve of the press mold block by a plate, while the second is attached to the upper cylinder plate and moves together with it.

The feeder consists of a hopper, located behind the frame and installed on a plate, which is secured to the female die plate of the press mold block. A cartridge is moved with a parallelogram unit along the plate in guides under the action of a hydraulic cylinder. A pusher is attached to the front part of the cartridge.

A step belt conveyor is used to secure the articles before they are stacked on pallets for sintering. The conveyor is driven during the downward stroke of the upper cylinder plate through a rod with adjusting nut, pusher, system of levers and free-wheeling clutch to the drive roller of the conveyor. The hub of the clutch is connected to the shaft of the drive roller and rotates it. The angle of rotation of the drive roller depends on the stroke of the pusher. The pusher is returned by spring.

The hydraulic drive and control system support operation of the automatic machine according to the following scheme: top press molding with natural floating and subsequent contraction of the female die.

Press molding is achieved with the speed of the upper male die slowing down, which is achieved by switching off the plate-type pump. The rate of molding can also be regulated over a wide range.

Articles can be molded by "pressure" (response of a pressure relay) or by "size," i.e., molding is completed upon reaching a specific pressure or when the press male die reaches a specific position with respect to the female die.

The hydraulic drive is a separate unit, installed on the base of a G48-85 hydraulic station, equipped with an AN1 pumping assembly and an AN2 pumping unit. The pumping assembly consists of a high-pressure axial-piston pump and plate-type pump to create pressure in the line of the cartridge drive. The pumping unit consists of a plate-type pump and is used to create additional delivery of working fluid during no-loads of the upper and lower cylinders.

The hydraulic station consists of a hydraulic tank with filter and oil-cooling devices, pumping units, hydraulic panel with vertical panel, to which is installed a distributing and monitoring-regulating hydraulic apparatus, housing which encloses the pumping units, and hydraulic panels of the electrical equipment of the electrical equipment of the hydraulic drive with electric motors of the high- and low-pressure pumps.

The hydraulic system together with the electrical system supports operation of the automatic machine on adjusting, semiautomatic (single cycles) and automatic modes. The hydraulic system provides the following in the semiautomatic and automatic modes:

automatic delivery of powder from the hopper to the female die;

press molding of the powder in the female die to a specific adjusted pressure;

magnetization and demagnetization of the product during press molding;

withdrawal of the female die from the article;

pushing the article onto a conveyor;

accumulation of articles on the conveyor or when using a robot, transfer of articles from the conveyor to ceramic plates of the furnace for baking.

The operating cycle of the automatic machine with cartridge and suction of powder into the cavity of the female die begins with pushing the finished article and pouring powder into the female die, i.e., with the forward motion of the feed cartridge. In this case the female die and central rods are in the extreme lower position while the upper cylinder plate is in the extreme upper position. Rise of the female die plate begins in the forward position of the cartridge. During this time, the cartridge moves backward and is again returned to the extreme forward position, i.e., it makes oscillatory forward-backward motions above the female die. The powder then fills the cavity of the female die. The duration of the oscillatory motions of the cartridge of the female die can be regulated by adjusting a time relay. After the cartridge has been removed to the extreme rear position, a slide valve moves downward quickly. Molding occurs during retarded motion of the upper cylinder plate. The speed of the upper cylinder plate is regulated over a wide range.

Simultaneously with the beginning of movement of the upper cylinder plate, the upper and lower magnetization coils are switched on and the orientation of the oxide powder in the magnetic field is switched on. During this time, there is natural "floating" (motion) of the female die downward due to the effect of the compressed powder as a result of coupling forces between the particles and walls of the female die. Upon reaching a given molding pressure (during "pressure" molding), the article is maintained at this pressure and then the pressure is released. Simultaneously with the beginning of holding the article under pressure, the magnetic field of both coils is switched to demagnetization. After the release of pressure, the upper cylinder plate begins to be raised upward rapidly. After the upper cylinder plate has been raised with the upper male die to the extreme upper position, the female die is withdrawn from the molded article. The magnetic field of both coils is switched off with the female die in the lower position, the cartridge moves forward, pushing the finished article onto a conveyor, and the cycle is repeated.

The design of the automatic machine is protected by Inventor's Certificate 393041 (USSR).

The special hydraulic automatic machine for press molding of magnets from oxide powders meets modern economic and aesthetic requirements.

The saving due to introduction of the automatic machine is 8,178 rubles per year. The manufacturer is the Experimental Plant of ENIKmash [Experimental Scientific Research Institute of Forge and Press Machine Building (Voronezh)].

6521
CSO: 1861/193

UDC 621.979-82

REDUCTION OF READJUSTMENT TIME OF AUTOMATIC PRESSES

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 1, Jan 86 pp 11-13

[Article by I. I. Yegorov and A. Kh. Tlibekov]

[Text] An increase of productivity is achieved under conditions of large-series production mainly by increasing the speed of the automatic press. The time expended on readjustment is of important significance under conditions of medium- and small-series production.

Readjustment of a sheet-stamping automatic press includes replacement of the dies, adjusting the delivery unit and material guide unit, loading the material to be processed and if necessary, adjusting the material straightening, cleaning and lubricating mechanisms and devices for waste removal.

Replacement of the dies and adjustment of the delivery unit and material guides occupies the greatest part of time (up to 90 percent).

The functions (Figures 1 and 2) were determined for the automatic press with 300 strokes per minute at load factor of 0.8 s with regard to the fact that the equipment operates in two shifts and a lot equal to the monthly program is die-forged simultaneously.

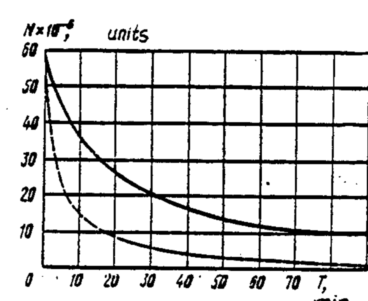


Figure 1. Dependence of Annual Productivity of Automatic Press on Readjustment Time: — — — --c = 10,000 parts/year; ——— --c = 50,000 parts/year

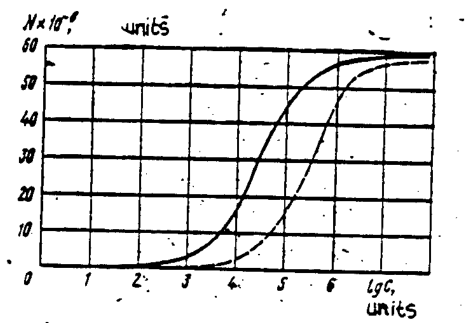


Figure 2. Dependence of Annual Productivity of Automatic Press on Series of Parts To Be Die-Forged——— --T = 10 min; – – – --T = 90 min

Analysis shows that the productivity of the automatic press decreases with an increase of readjustment time, especially acutely when die-forging parts in small series.

One of the methods of reducing the readjustment time of the delivery roller mechanism is to use a step motor with numerical control (NC) as the drive. The precision of the delivery step of these units is provided by checking its value, by comparison to the given value and by making constant corrections to the step motor control signal. Moreover, the NC unit provides optimal conditions of material delivery at which the rollers rotate at a constant speed after the runup stage of the rollers, which comprises 5-10 percent of the period of motion, and they are then decelerated, equal in length to acceleration time. Thus, the time of motion of the material with acceleration does not exceed 20 percent of the delivery period per step. The precision of delivery reaches ± 0.02 mm.

However, the productivity guaranteed by them within the range of guaranteed accuracy depends on the spacing of delivery. If spacing of 10 ± 0.02 mm is provided at number of strokes of 8 s^{-1}, then spacing of 50 ± 0.02 mm is provided only at number of strokes of 3 s^{-1}. Therefore, the use of numerical program control for the drive of roller delivery of a high-speed automatic press is unfeasible. Its use can be economically effective in flexible automated sheet-stamping production systems.

The movement of the material at which its runup and deceleration stages comprise less than 20 percent of the delivery period per step is achieved by the roller mechanism presented in Figure 3 [1]. A friction clutch, which transfers rotation from the drive to rollers 1 and 10, is used in the design. A semiautomatic clutch 9 is installed on a shaft 4 and is connected to a push rod 6, which contacts a cam 7. Sections, arranged symmetrically around its circumference, are made on the end part of the cam.

Rotation of shaft 4 through the clutch is transmitted to rollers 1 and 10 and a belt is moved. In this case push rod 6 does not interact with the section of

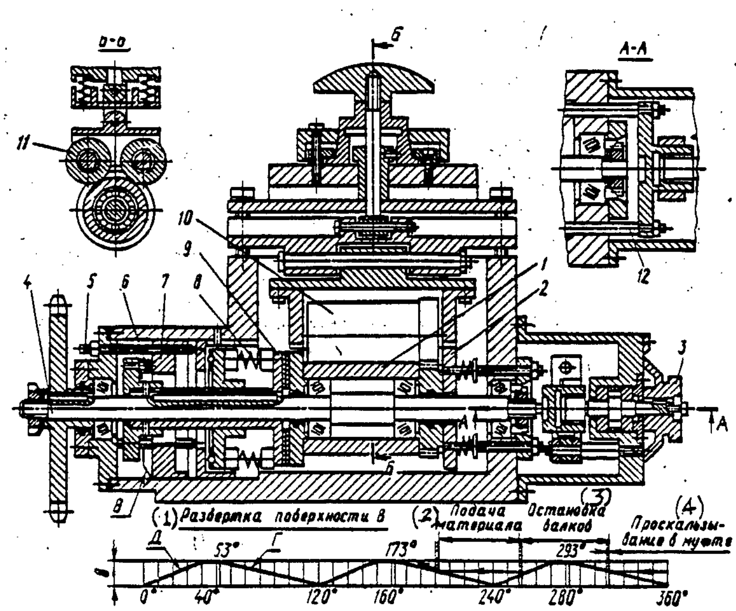


Figure 3. Roller Delivery Mechanism

KEY:

1. Scanning of surface B
2. Delivery of material
3. Stopping of rollers
4. Slipping in clutch

cam 7. Their interaction causes axial motion of the semiautomatic clutch 9 with respect to shaft 4, interruption of contact of the semiautomatic clutches and stopping of the rollers and belt for the time of molding it in the die. The gap between the section and push rod 6 is changed by axial movement of the cam 7. The angle of rotation of the rollers, on the length of which the clutch is in the open state and the belt to be delivered is immobile, is changed. This regulation is achieved without stopping the operation of the press by rotating the reading dial 3, which moves rods 12, connected to cam 7. Cam 7 is moved by 2 mm during one rotation of dial 3, providing a change of the step from 0 to 12.5 mm. The scale division of the dial of 0.035 mm/degree permits the spacing of delivery to be set with great accuracy. The maximum spacing of delivery (50 mm) is set during four revolutions of the dial.

The section of cam (see Figure 3) provides smooth disconnection (G) of the semiautomatic clutches and more rapid engagement (D). This permits one to reduce the dynamic loads at the end of the delivery step, whereas the torque on shaft 1 is increased rapidly at the beginning of the step.

A constantly engaged brake 2 is used to prevent the rollers from rotating due to inertia. The compressive force of the semiautomatic clutches is regulated by rotation of screws 5, which lead to compression of springs 8.

The unit is additionally equipped with a spring-loaded roller 11, connected by a gear to drive shaft 1 [2, 3], to increase the precision of the delivery step.

The advantages of the described unit over a drive using free-wheeling clutches is shorter readjustment time and higher precision of delivery step. There is the capability of decreasing the rotational speed of the drive roller two-thirds as much by using three identical sections of the cam, without reducing the productivity of the automatic press. A decrease of the rotational speed of the roller reduces the accelerations in the runup and deceleration stages, which reduces dynamic sliding of the rollers and material. The roller mechanism provides accuracy of spacing of ±0.05 to ±0.1 mm when material from 0.05 to 0.8 mm thick and up to 50 mm wide is delivered.

Deviation in the direction of motion of the belt with respect to the rotational surface of the rollers must be taken into account when installing the roller mechanism on the housing of the automatic press. It is controlled primarily by the guide strips of the die. Equipping the automatic presses with special die attaching assemblies, which guarantee setting error not exceeding ±0.5 mm, and with guide and belt centering assemblies with respect to the longitudinal axis of the die space permits a reduction of their readjustment time and provides the required accuracy of delivery step.

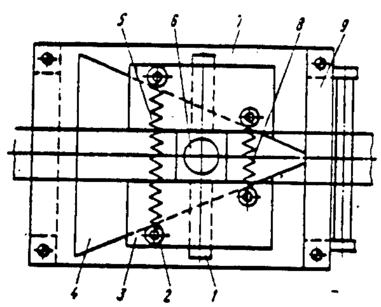


Figure 4. Guide Unit

The guide unit (Figure 4) contains a feeler mechanism 4, having the shape of an equilateral triangle, attached to a base 7. Guide strips 3, which can be moved along the lateral sides by rollers 2, are installed on the feeler mechanism 4. The rollers of one of the strips are connected in pairs to the rollers of the other strip by tension springs 5 and 8 to ensure constant contact of the rollers 2 to the lateral surface of the feeler mechanism.

Columns 1, to one of which a lever 6 is attached, are installed perpendicular to the axis of belt delivery for free motion of the guide strips 3 when adjusting the unit. A stop 9 is installed on the base 7 to hold the guide strips in the inoperative position.

The unit for attachment of dies 5 and 6 (Figure 5, a) consists of two blocks that attach the upper part of the die to a crosspiece and the lower part to the press table. Two bevels (C), which interact with the movable 1 and fixed 3 guides when installing the die, are made on the die plate. The die installed between the guides moves to the stop. The upper part of the die is attached to the cross-piece by the cam mechanism of pneumatic chamber 8. The cam mechanism contains a spring block 5, fastener 4 and cam 6 and push rod 7 connected to them and which interact with the cam section.

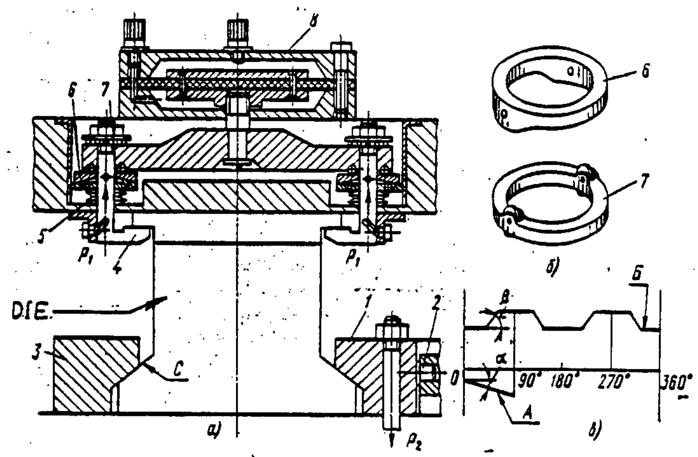


Figure 5. Device for Attachment of Dies (a); Cam and Push Rod (b); Scanning of Cam Sections and Spiral Groove of Fastener (c)

A special groove A (Figure 5, c) with angle of pitch α is made on the fastener. The angle of pitch β of the cam section 6 is greater than the angle of pitch α of the spiral groove section and it is aligned in the opposite direction for fixing in the position in which the tool is pressed and also for compression of spring block 5. Upon rotation of the cam, the push rod moves downward and the disk spring block is thus compressed and the die is secured. Mechanical clamping of the die is achieved by means of fasteners held in the working position by the cam. The pneumatic chamber serves to drive the mechanism and create additional clamping force P_1. The die is held by the cam mechanism in case pressure in the pneumatic system drops. The pressure to the upper cavity of the pneumatic chamber must drop to release the die.

The clamping force P_2 of the lower part of the die is created by a similar device using a pneumatic drive. Its action causes the movable guide 1 to rotate with respect to axis 2.

Thus, when using the given design of the unit for accelerated attachment of the die, readjustment includes placing it on the press table between guides 1 and 3 and in moving to the stop. Clamping is achieved from a pneumatic drive. The process of readjustment occupies 1-1.5 min. Moreover, the guides provide total compensation of errors in installation of the pay-out device and the deviation in the direction of motion of the belt does not exceed 1-2°. This angle of deviation does not affect the error of the delivery step.

The use of roller delivery designs, a guide for the belt and unit for accelerated attachment of dies to the automatic press made it possible to reduce the period of readjusting them to 10-15 min and to increase productivity 2.5-3-fold when stamping lots of parts of up to 100,000 units.

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6521
CSO: 1861/193

UDC 621.979.06

AUTOMATION OF LOADING AND UNLOADING OF BLANK SHEETS ON NC JIG-TURRET PRESSES

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 1, Jan 86 pp 14-15

[Article by S. B. Chelishchev, M. A. Sitnikov and A. D. Safonov]

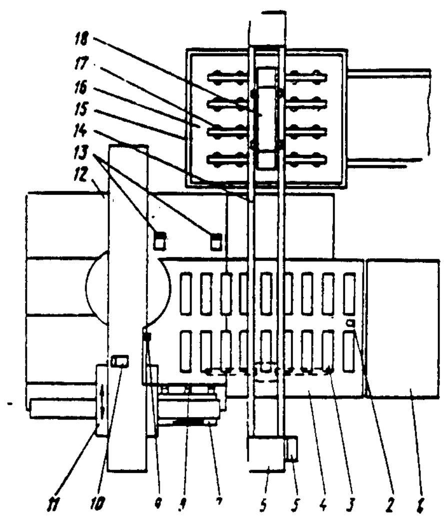
[Text] NC jig-turret presses are finding ever greater application at enterprises of different sectors of industry. Operational analysis of NC jig-turret presses shows that K0126P presses, produced serially by the Chimkent PO [Production Association] for Manufacture of Jig-Turret Presses, are used to manufacture panels, doors and chassis and also small parts: washers, petals, covers and so on. The possibility of multitool servicing is realistic in this case, but automation of loading and unloading of blank sheets are required for this. The use of devices for automatic loading of blanks and removal of finished parts permits one to machine large and massive blanks without additional time expenditures.

Development of a complex of NC jig-turret presses or of a machining center based on it and devices for automatic loading of blanks and unloading finished parts is essentially the design and development of a flexible retooling module.

Devices for automatic loading and unloading of blank sheets of model UZVL-1 were designed at ENIKmash [Experimental Scientific Research Institute of Forging and Press Machine Building], parallel with design and development of the OTsK0126F4 machining center (Footnote 1) (S. B. Chelishchev, A. D. Safonov, O. P. Bigun et al., "Machining center for Manufacture of Blank Sheet Parts," KUZNECHNOSHTAMPOVOCHNOYE PROIZVODSTVO, No 5, 1984, pp 24-26). A block diagram of an automatic sheet loading and unloading unit model UZVL-1 is presented in the figure. A pile of blanks 16 with overall dimensions up to 1,600 x 2,000 mm and with mass up to 70 kg each is stacked on a cart 15. Guides 14 of crosspiece 6 are located above the cart. A carriage 18 with pneumatic suction units 17 moves along the guides. A conveyor 4 is located under the guides 14 in the zone of the initial position of the OTsK0126F4 jig table of the center and stops 13 are located on fixed plates of the support table of the center. Inventor's certificate 967623 (USSR) is used in the design of the UZVL-1.

A blank is loaded onto the jig table of the center in the following manner. The cart 15, having individual electric drive, is moved to the extreme

righthand position, in which it is loaded with a pile of blanks. The blanks in the pile can be of the same size or of different sizes, previously stacked in the pile in sequence, for example, for the program of one shift. The position of the stack 16 on the receiving cart 15 is not strictly regulated, since it occupies the required position upon subsequent orientation of the blank on the table of the center. The cart loaded by the operator is returned to the initial position under carriage 18. The height of the pile of blanks is 250 mm. After receiving the command "cart in initial position" and upon receiving a command from the numerical program control of the center "operate in automatic mode," the suction units 17 are lowered and switched on. A sheet is suctioned within 0.5-1 s and is raised by the frame of the carriage 18 to the extreme upper position. When the frame of the carriage reaches the upper position (the vertical stroke of the frame is 300 mm), a command is transmitted to move the carriage 18 toward the conveyor 4, the cart with the sheet is moved along guides 14 and stops above the roller conveyor in a position denoted on the figure by the dashed curve. The sheet is located at a height of 15-20 mm above the conveyor table. The carriage is stopped by a command to switch off the suction units, the blank is laid on the receiving table of the conveyor 4 and rollers 3 are raised and begin to rotate to the left, thus moving the sheet to the machining zone. Simultaneously with raising and switching on the roller conveyor, the carriage is returned to the initial position and receives the next command to continue operation. The blank moved by the conveyor comes into contact with its left end with end cap 9, which serves as an instruction to stop rotation of the rollers 3 and lower them.



The blank is lowered to the supporting spherical bearings of the roller conveyor table in the zone of the beginning of automatic orientation of the blank by the jig table of the machining center. The cycle of loading one blank is achieved within 10-15 s. This time is equal to 10 s if the next blank intended for machining on the machine center is first raised by the cart and is 15 s if the loading cycle begins after complete removal of the finished part from the conveyor table. The suction units 17 can easily be reset to the required position along the transverse beams supporting them to expand the capabilities of the UZVL-1 unit and for quick retooling (if necessary) to manufacture new parts.

The transverse beams can be secured in any position of the frame of carriage 18. Identically fast loading of blanks measuring 500 x 500 x 1,600 x 2,000 mm can thus be provided. Manipulations with a blank are simple and the mechanisms are reliable in operation.

Automatic orientation of the blank to the jig table of the center is achieved in the following sequence. The carriage 11 of the jig table is in the initial extreme position, while carriage 7 is in the extreme left-hand position. The sheet holders are open. Carriage 7 is moved to the extreme right-hand position when the command "sheet loaded" is received. This position corresponds to that of carriage 7, shown in the figure. Two stops 13 are raised simultaneously above the surface of the support table 13. Carriage 11 begins to move at speed assigned by the NC toward stops 13. The open jaws of the sheet holders 8 catch the front edge of the blank, supported by the spherical bearings, and move the blank toward stops 13.

Stops 13 are spring-loaded, have two fixed positions (lowered and raised) and a third intermediate position, in which the signal to the NC unit is fed that the blank has come into contact with the stop. The moment when both stops 13 signal contact with the blank is the basis for stopping the carriage 11 and for the jaws of the sheet holders to clamp. The stops 13 are lowered after the blank is clamped and carriage 11 is returned at greater speed to the initial position, while stop 10, having the same design as stops 13, is raised. Carriage 7 is moved to the left until it contacts the blank with stop 10.. The moment the signal is transmitted by stop 10 is fixed by the NC unit, the difference between the actual position of the blank and the point of zero readout of the jig table is entered in the memory of the NC unit and the blank is grasped along the coordinate of carriage 7 according to this value. The time of the blank orientation cycle depends on its dimensions in layout; the larger the blank, the shorter the distance the carriages of the table move at reduced speeds and the shorter the time expended on orientation. This time does not exceed an average of 30-45 s. Taking into account that the operating length of the spherical screw of the carriage drive 11 comprises 800 mm, the size of the automatically oriented blank along the coordinate of the carriage 11 should also not be less than 800 mm. There are also constraints of a structural nature, related to the arrangement of stops 13 on the table of the center, according to the size of the blank along coordinate x. This dimension should not be less than 800 mm. It should be noted that stops 13 and 10, like the carriages of the jig table, are related to the center, with regard to which it is possible to use the automatic blank orientation mode during manual delivery of blanks to the orientation zone, thus reducing the fraction of manual labor by the operator. Having completed the automatic orientation cycle, the jig table moves the blank to the initial position for work, after which the machining center automatically manufacturers the part according to the control program by sequential piercing of holes at the given coordinates. The table moves the manufactured part to the extreme right-hand position of carriage 7 upon completion of the manufacturing cycle so that the condition is provided in which not less than 50 percent of the part area is on the roller conveyor. Carriage 11 should be in the initial position in this case. The sheet holders are opened and carriage 7 is moved to the extreme left-hand position. The roller conveyor is raised at command from the NC unit and clockwise rotation of the rollers begins, rolling the finished

part from the zone. The design of the UZVL-1 provides that the finished part can be unloaded by one of two versions. The first includes rotation of the roller conveyor until the moment the part is transferred for subsequent machining, for example, for cutting the small pierced sheet by specialized shears into small rectangles. The second version includes stopping the conveyor for the moment when the right edge of the part comes into contact with switch 2. The rollers are lowered in this case by a command to raise the support plate of the conveyor. The angle of rise of the plate can be regulated so as to provide reliable sliding of the part on the inclined receiving table 1, from which the parts are removed after accumulation and as needed by means of shop transport vehicles. A command to move the carriage 18 with blank toward the conveyor is transmitted when the support plate is lowered to the initial position (the frame with pneumatic suction units is lowered and the blank can be raised parallel with the cycle of removing the finished part from the table of the machining center).

The time of loading the finished part from the table of the center is 5-8 s. The unit has a console 5 for stand-alone control of the loading and unloading units, which is used during debugging of the production process on the complex.

The total time of preparatory operations (loading, orientation and unloading the blanks and parts) is no more than 1 min if the NC jig-turret press and specifically if the machining center is equipped with automatic loading and unloading units of model UZVL-1, which permits one to achieve a time load factor of the center of 0.8-0.9 with regard to the machine time (5-10 min) of machining the blank on which several parts are located. The operator essentially only observes the operation of the mechanisms in this case and has the capability of performing multimachine tool maintenance. The tool in the revolving head is replaced and a new lot of blanks is installed on the cart between shifts or on the third shift.

The area occupied by the OTsK0126F4 center without loading and unloading units of model UZVL-1 comprises 24 m^2 and with UZVL-1 unit comprises 37 m^2. The mass of the UZVL-1 unit is 3,550 kg. The UZVL-1 unit was tested in combination with the OTsK0126F4 machining center. Determined deficiencies were taken into account in modification of the unit during correction of the technical documentation.

The saving due to introduction of the UZVL-1 unit due to conservation of auxiliary time and the capability of multimachine tool maintenance comprises 5,000-10,000 rubles annually.

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CSO: 1861/193

UDC 621.762-621.73.043.8

EXPERIENCE OF INTRODUCING ROBOT-ASSISTED DIE-FORGING CELL BASED ON 40 MN HOT-DIE-FORGING CRANK PRESS

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 1, Jan 86 pp 16-17

[Article by A. A. Krivitskiy, O. A. Rusanov, V. N. Sokolov, B. I. Vatolin and I. A. Olyshanskiy]

[Text] An interdepartmental commission has accepted the AKKA8546.1 automated production complex (RTK) based on hot-die-forging crank press with force of 40 MN with industrial robot (PR) having capacity of 40 kg with the highest category of quality at the Pskov Gear Plant (PZZK). The complex is designed for stamping round parts of the pinion type and was developed and manufactured by PKTIkuzrobot. The equipment productivity was increased 1.5-fold, the die maker and his helper are freed, the working conditions of the operator are improved, one operator can service two complexes and cases of production injury are eliminated.

Industrial robots are installed along the conveyors and service the press die through side windows.

Freer access to the die forging space is provided with this design version of the complex, which permits rapid replacement of the die using shop mechanization units when retooling to manufacture other articles; this is especially important for enterprises with small-series production.

Moreover, the process is simplified in cases when it is necessary to readjust the complex for manual servicing.

The automation units of the complex can be retooled within 10 min to produce articles of different dimensions.

The stability of the die is increased 1.5-fold due to automatic cooling and wetting of its impressions and also temperature stability of the blanks to be die-forged is also increased.

The mass of the blanks is reduced due to reduction of tolerance for flash, which is higher than in manual placement, with accuracy of positioning the blank in the shaping impression of the die.

The saving due to use of the complex, depending on the production process of the part to be manufactured, comprises up to 100,000 rubles.

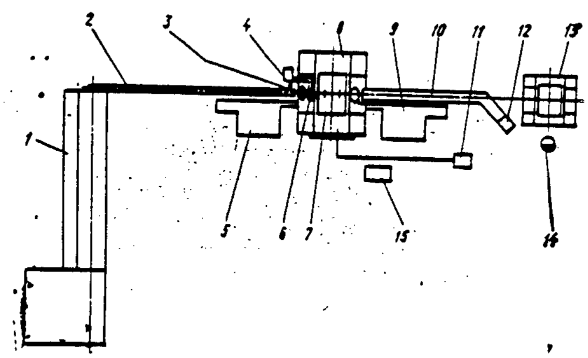
Specifications of Complex

Rated force of press, MN	40
Capacity of robots, kg	40
Blank diameter, mm	90-150
Maximum forging diameter, mm:	
without flash	260
with flash	330
Maximum length of blank, mm	290
Duration, units/min (with two-impression die-forging)	3

The complex operates in the following manner in automatic mode (sequential program):

The blank heated in an inductor 1 (figure) is moved by a chain conveyor 2 to an orientation device 3, where its temperature is checked by a pyrometer 4.

The robot gripper 5 is then lowered, it clamps the blank located in the orientation device in the horizontal position, raises it and rotates it to the vertical position at normal heating temperature above chute 6 and moves it to the first impression of the die 7.



If the temperature of the blank is below the permissible value, the robot arm stops above chute 6 upon command without rotating the blank, drops the under-heated blank and returns to the initial position for the next blank.

After the robot arm, having left the blank in the first groove of the die, returns to the initial position, the slide of the hot-die-forging crank press 8 completes its operating stroke, stamping (swaging) the blank. When the slide stops in the extreme upper position, the robot arm is returned to the die-forging zone, retrieves the swaged blank from the first impression, installs it in the second impression of the die and returns to the initial position.

Robot arm 9 with open gripper is moved to the die-forging zone after die-forging the forging in the second impression when slide stops in the extreme upper position, the push rod raises the forging from the impression, the robot grippers grasp it and remove it from the die-forging zone to chain conveyor 10.

The die impressions are purged and lubricated by lubricator 11 at the end of the die-forging cycle.

The forging is then moved by the conveyor 10 to table 12, from which a worker 14 transfers the forging with forceps to trimming press 13.

The complex is controlled by an automatic program control system 15.

The complex operates according to a sequential program when the heater provides the rate of delivery of the blanks, equal to 1.5 blanks per minute.

If three blanks per minute are delivered, the complex automatically transfers to operation according to the combined program, which includes the fact that robot 5 begins to operate simultaneously with the beginning of operation of robot 9, i.e., robot arm with gripper 5 begins to be lowered simultaneously with movement of robot arm 9 to the die-forging zone for a forged part so as to take the next blank from the orientation device. Both robots then operate simultaneously until the gripper of robot 9 is opened to release the forging onto the conveyor. In this case the operating cycle of robot 9 is completed, while robot 5 continues to complete motions in the sequence described above.

An automatic line with complete automation of all operations (from unloading the blanks from the inductor to unloading the trimmed forgings and flash from the trimming press) has been developed on the basis of the AKKA8546.1 complex and K9536 trimming press with force of 4 MN.

The expected saving due to introduction of one automatic line comprises up to 170,000 rubles.

The control system of the complex was developed on the basis of the UTsM-663 cyclic program control unit. The unit is designed on the principle of a synchronous automaton with rigid control cycle and is intended to control industrial robots operating with positioning according to rigid cycles.

The unit provides simultaneous control in six coordinates, transmission of 12 production commands and receipt of confirmation of their execution. The unit can receive up to 20 interlocked signals to ensure trouble-free operation.

The main operating modes of the UTsM-663 unit are the following: "Manual," "Adjustment," "Command," "Frame," "Cycle," "Automaton" and "Assignment of program."

The device is connected to equipment through coupling assemblies that perform some logic functions and also serves to coordinate the equipment of the complex with the UTsM-663 according to electrical parameters. It controls five coordinates in the AKKA8546.1 complex, transmits nine production commands and receives signals that confirm their execution, monitors adherance to conditions required for operation of the complex in the automatic mode and gains access to the corresponding subroutines written in the memory of the unit.

The electrical equipment of the complex permits one to use all modes and functional capabilities of the UTsM-663 unit, which provides ease of adjustment and regulation of equipment.

A time relay that monitors the time the hot blank is held in the gripper of each of the robots (in any operating mode of the complex) is installed in one of the coupling assemblies, which is necessary to protect the gripper against overheating upon failures of the equipment. If the part in one of the grippers remains clamped for more than 10 seconds, the time relay breaks the electric contact.

End switches, through which a signal for switching on the press clutch passes sequentially, are installed on the arms of both robots in addition to programmable and nonprogrammable interlocking in the UTsM-663 to ensure trouble-free operation of the complex. This interlocking permits one to ensure the safety of the robots upon any failures of the UTsM-663.

Upon introduction of the complex, there was a need to conduct investigations on automation of the K9536 trimming press with force of 4 MN (see Figure 1, item 13), installed in the same production chain with the die-forging crank press.

PKTIkuzrobot is working out the technical documentation for a line to manufacture forged parts with a forging--flash trimming production cycle.

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AUTOMATED LINE FOR DIE-FORGING COMPRESSOR HOUSING

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 1, Jan 86 pp 13-14

[Article by V. V. Petrov]

[Text] VPTIElektro [All-Union Planning and Design Institute of Electrical Engineering Production Technology] has developed and introduced an automated line for die-forging a compressor housing (Fig.1) based on two universal crank presses of model KD2328 with force of 630 kN using two PRP-5 two-arm robots.

A diagram of the automatic line for die-forging compressor housings is presented in Figure 2. The compressor housing, after the end has been cut off on a two-spindle automatic turning lathe, is delivered in pieces to an inclined chute, along which it rolls to a window at the end of the chute, falls into it and is then fed along a slide to an inclined roller conveyor in the oriented position (bottom downward). The part moves along the roller conveyor to an intermediate table with the unit for piece delivery of blanks. The unit is installed at the end of the roller conveyor and is located near the first crank press. The piece delivery unit is set into operation from a special sensor based on an end switch and installed on the roller conveyor at a distance of 4 part diameters from the intermediate table after a specific number of parts have been accumulated on the roller conveyor. When the parts are on the roller conveyor in incorrectly oriented position (bottom upward), the sensor does not respond and operation of the piece delivery unit is stopped. If the parts are correctly oriented, the piece delivery unit delivers the blank from the intermediate table to the grab of the PRP-5 robot. The first arm of the PRP-5 robot, located near the first press of the line, grasps the blank on the piece delivery unit, while the second arm grasps the stamped part from the reducing die and calibrates the part in diameter. The robot column rises with the arms attached to it and rotates by a given angle. The first arm is then extended and the part is released from the clamps and in this case the first arm places the blank into the die while the second arm places it into the receiving unit of a tilting mechanism. Both arms are then retracted and rotated to the initial position: the first arm above the piece delivery unit and the second in front of the reducing die installed on the press. At this moment, the press responds and the production operation of reducing the blank is executed. The next part is simultaneously delivered under the grab of the first robot arm, the tilting mechanism is triggered, which transfers the blank to the inclined roller conveyor, driving it to the second press of the line in the given position (bottom upward) for the operation of drilling side openings. Interlocking is provided to ensure reliable and

trouble-free operation of the first robot: for failure of the robot grabs to remove parts from the piece delivery unit and from the die after the calibration operation, for the case of failure of the tilting mechanism to respond and of overloading the roller conveyor, leading to the second press of the line. Interlocking is also provided for the press to respond only with the robot in the initial position. The press control system is switched off in all remaining positions of the robot and the signal to switch on the robot is not delivered, while the response of the robot and of all the systems is possible only with the slide valve in the upper position. The operation of the first robot in combination with all the equipment that delivers, machines and removes the press parts is achieved by a UTsM-30 control system according to the program selected by the operating cyclogram.

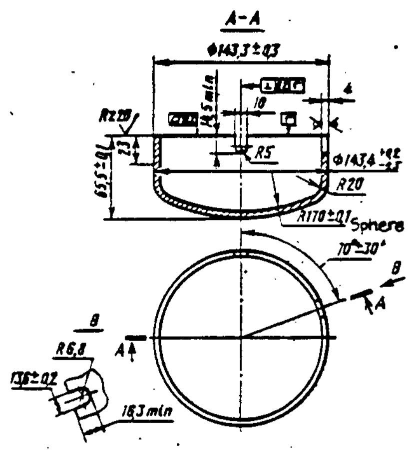

Figure 1. Compressor Housing

The clamped blank is fed from the tilting mechanism along an inclined roller conveyor to an intermediate table, located near the second press of the line. If the parts are correctly oriented (bottom up) and if a specific number of them are on the roller conveyor that provides reliable location of the part in the receiving unit of the intermediate table, the piece delivery unit is triggered from a special sensor installed on the roller conveyor and the blank is delivered to the gripper of the robot, installed near the second press.

The first arm of the robot grasps the blank on the piece delivery unit and the second grasps the part located in the female die of the broaching die. The arms are raised, retracted, rotated, extended and lowered. The blank is installed in the female die of the piercing die for execution of the production operation, while the finished part with pierced grooves is lowered to the roller conveyor, along which it is delivered to the drive conveyor and is then delivered for rinsing. The robot arms are then returned to the initial position and the cycle is repeated.

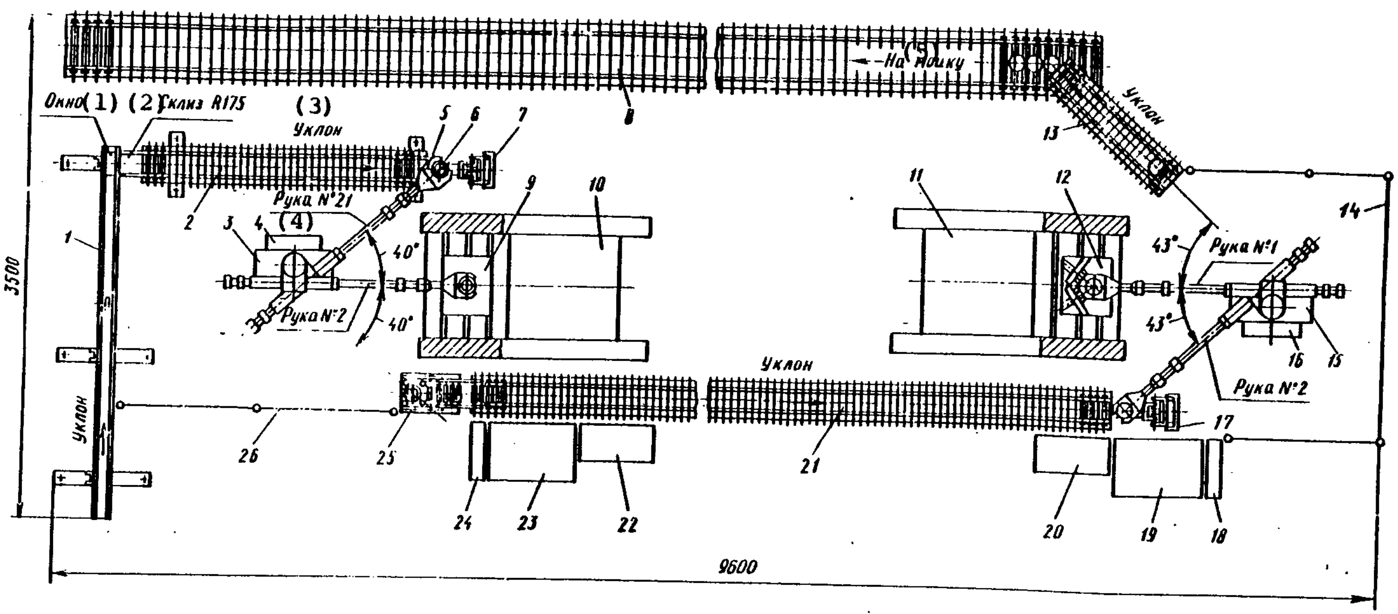

Figure 2. Automatic Line for Die-Forging Housing: 1--inclined chute; 2, 13, 21--inclined roller conveyor; 3, 15--PRP-5 robot; 4, 16--robot pneumatic control unit; 7, 17--intermediate table with blank piece delivery unit; 8--drive roller conveyor; 9--reducing die; 10, 11--KD2328 press; 12--piercing die; 14, 26--enclosure with door interlocked with robot electric circuit; 18, 24--matching module; 19, 23-- UTsM-30 control unit; 20, 22--electric cabinet of press; 25--tilting mechanism

KEY:

1. Window
2. Slide
3. Slope
4. Arm
5. To rinsing

The same interlocking as for the first robot is provided for trouble-free operation of the second robot. Its operation is supported by a second UTsM-30 control system by a program developed according to the corresponding cyclogram for the second robot. Operation in the semiautomatic mode is possible if one of the robots fails.

The operating cycle of the line is 11-12 s. The capability of manufacturing two housings, different in height, on a line of the same dimensions is provided.

The use of robots eliminates unskilled, exhaustive and monotonous labor. Production skills and safety techniques were improved.

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ON MODELING STRUCTURE OF UNITIZED SYSTEM OF AUTOMATICALLY OPERATING MACHINES

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[Article by A.M. Tsaryov and S.V. Ulyanov, Togliatti; boldfaced passages are rendered in italics in the original]

[Text] At early stages of developing systems of automatically operating machines it is necessary to identify fields of structural and lay-out versions, i.e. to conduct a purposeful search for optimal structure and lay-out [1-3].

The multivariance of forming a workpiece machining route, structure selection and lay-out of a machine system leads to a variety of modifications. This article examines forming of the machining route and equipment structure as a necessary and concerted procedure in developing a machine system.

We shall write the representation of the object of machining in the form of a mathematical model $D=\langle J, R\rangle$, where $\{J= J_1, J_2, ..., J_N\}$ is a set of machining elements, R is a binary two-valued relation on J. If, for instance, R is a relation of "precedence" or "following", then model D makes it possible to follow all possible sequences of machining a given machined object. Machining elements are structural elements of the overall machining allowance. A set of machining elements forms a basis for identifying a set of machining methods, tooling and equipment. In this case, any machining element J_k will be matched one-on-one by a production operation of machining a given element J_k.

The sequence of machining is determined by time sequence of machining operations for an element from set J. For two elements, performing of the operations can take a sequential "·" or a parallel "+" meaning. For a general case relation J_1RJ_2 at $J_1, J_2 \in J$ one can identify binary relations between machining elements, for instance, $J_1=001$, $J_2=002$ (Figure 1): 000·002 is a relation of sequential machining of two elements in time, and 001+002 is a relation of parallel machining of two elements. t_{001} and t_{002} parameters are considered to be sets of states of equipment in the process of machining elements 001 and 002 in time on a continous time number axis from a zero reference point of the start of machining.

Structurally, an automated machine system is a group of ordered and

interacting sets of systems and subsystems, that are called units or unit blocks. The latter can be single- and multi-level. Multi-level units are formed in the process of unitizing on the basis of single-level units. In turn, a single-level unit as a structural element is a subsystem, which is considered indivisibleat the structural synthesis stage. A unit has an input, transformation and output of signals, that have an electrical, mechanical or other form [4].

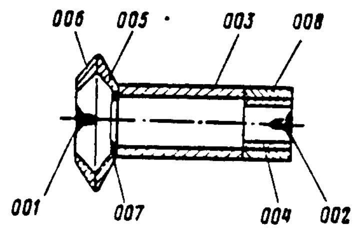


Figure 1

The variancy of single-level units is determined by their functional duty, the number of types and standard sizes, functional independence, the variancy in the number of components, that determine the structure of a single-level unit, and by the variancy in accordance to belonging to the system unitizing level.

Variancy of Functional Duty. According to their duty, units of an automated system can be attributed to one of the following sets of equipment: 1) units with machining functions, that, as a part of a system, perform a process of forming a machined part (the object of machining); 2) units with functions of loading blanks, unloading machined parts and transfering and accumulating parts between units (or between stations); 3) units with control and diagnostic functions.

Types and laws of functioning of single-level units meet the requirements of single- or multi-purpose technological duty. A set of single-level units serves as a unified element base for unitizing in the development of unitized machine systems.

In unitizing a machine system, a unit must meet the following requirements: a place in the system-forming space and in time, qualitative composition, connections between elements and laws of functioning are specified or can be specified; quality parameters, composition and laws of functioning are guaranteed for an existing unit, that is available for application within the system, or can be guaranteed for a unit, that has to be developed within the time interval of functioning during the subsequent operation of the unitized machine system; within its application time interval, the unit retains the required productivity, fitness for purpose and reliability.

Functional Independence of a Unit. A unit will be totally independent when it only has its own losses, both cyclic and non-cyclic. We will consider the

degree of functional independence of a unit to be a measure of linkage between units: a sequential and/or parallel process of units functioning and down-time.

Variancy in Accordance With Number of Components, That Determine the Structure of a Single-Level Unit. At the structural synthesis stage, the structure of a single-level unit is regarded as a union of sets of the following types of elements of a unit: drives $\{e_{ij1}\}$; transfer-transformation mechanisms $\{e_{ij2}\}$; actuators $\{e_{ij3}\}$; basic elements of a unit (foundation, frame) $\{e_{ik0}\}$: $E_i=\{e_{ik0}\}\cup\{\{e_{ij1}\}\cup\{e_{ij2}\}\cup\{e_{ij3}\}\}$ where i is a unitizing level, $i=\overline{1,u}$; j is a consecutive number of sets $\{e_{ij1}\}, \{e_{ij2}\}, \{e_{ij3}\}$; $j=\overline{1,M}$; k is a consecutive number of elements of the $\{e_{ik0}\}$ set, for a single-level unit k=1. For a $\{e_{ik0}, e_{ij1}, e_{ij2}, e_{ij3}\}$ set, where $e_{ik0}; e_{ij1}; e_{ij2}; e_{ij3}\in E$ we have $n(E_i)$, the number of types of elements on set $\{e_{ik0}, e_{ij1}, e_{ij2}, e_{ij3}\}$ the maximum value of $n(E_i)=4$.

Examples. A four-component single-level unit of the 1st unitizing level, $n(E_i)=4$, is a non-self-acting boring head, consisting of a head housing e_{110}, a drive e_{111}, a transmission mechanism to spindle turning e_{112} and an actuator, spindle e_{113}: $E_1=e_{110}\cup e_{111}\cup e_{112}\cup e_{113}$.

A three-component single-level unit of the 1st unitizing level, $n(E_i)=3$, is a spindle head with a drive, that has a housing e_{110}, a drive, engine e_{111} and an actuator, spindle e_{113} (Figure 2): $E_1=e_{110}\cup e_{111}\cup e_{113}$.

A two-component single-level unit of the 1st unitizing level, $n(E_i)=2$, is a boring head without a drive, that has a housing e_{110} and an actuator, spindle e_{113}: $E_1=e_{110}\cup e_{113}$.

A single-component single-level unit of the 1st unitizing level, $n(E_i)=1$, is a tooling setup, that consists of a tool e_{113}: $E_1=e_{113}$.

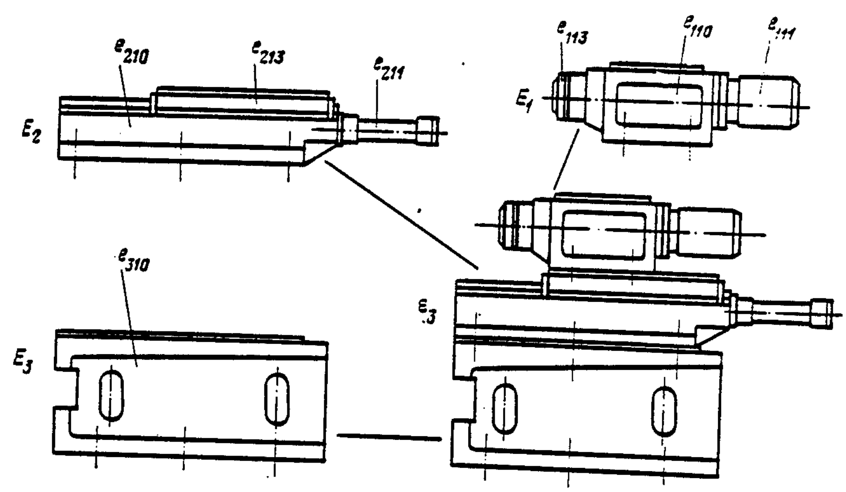


Figure 2

Variancy of Single-Level Units in Accordance With Their Belonging to System Unitizing Level. The single-level units, discussed above, belonged to the 1st system unitizing level. Here are examples of single-level units of the 2nd and 3rd unitizing levels in a machine system: a three-component single-level unit of the 2nd unitizing level, $n(E_i)=3$, is a powered hydraulic table with a base e_{210}, a drive, hydraulic cylinder e_{211}, an actuator, slide e_{213} (Figure 2), $E_2=e_{210}\cup e_{211}\cup e_{213}$. a single-component single-level unit of the 3rd unitizing level, $n(E_i)=1$, is a side bed of an automated transfer line e_{310}, $E_3=e_{310}$.

A common structural formula of a system as a multi-level unit of any unitizing level is $e_i=E_i\cup\{E_{i-1}\ldots\cup\{E_3\cup\{E_2\cup\{E_1\}\}\}\ldots\}$

Example. A multi-level unit of the 3rd unitizing level (Figure 2), where a single-level three-component unit of the 1st unitizing level is a powered head, a single-level three-component unit of the 2nd unitizing level is a power table, a single-level single-component unit of the 3rd unitizing level is a side bed. The structural formula of the multi-level unit (Figure 2) is

$$e_3=e_{310}\cup\{e_{210}\cup\{e_{211},e_{213}\}\cup\{e_{110}\cup\{e_{111},e_{113}\}\}\}.$$

For a machine system, at the lowest, 1st unitizing level, a unit is a single-level unit, a machining tool, and at the upper level a unit is a machining system as a whole. We shall represent sets of single-level units, correlated to respective i-th unitizing levels, with models $M_i=\langle E_i, R\rangle$, $i=\overline{1,u}$ u, where $E_i=\{E_{i1},E_{i2},\ldots,E_{iM}\}$ is a set of single-level units of the i-th unitizing level; u is the number of levels; R is a relation on the E_i set, that reflects relation of units of a given level.

For instance, a relation of "following" R at two units $E_{i1}RE_{i2}$, where $E_{i1},E_{i2}\in E_i$ determines time sequence of units functioning during machining of any existing elements of the object of machining from set J. Then a relation of "following" for two units of the same unitizing level, for instance, $E_{31}=301$, $E_{32}=302$ can be written as $301\cdot302$ and is a relation of time sequence of functioning of units of the third unitizing unit 301 and 302, whereas a relation of "following" 301+302 is a relation of simultaneous functioning thereof.

In a general case, model M of a machined item and a machine system is defined by listing elements and relations therebetween and is denoted $M=\langle A, R\rangle$, where $A=\langle a_1, a_2, \ldots, a_N\rangle$ is a set of elements; R is a relation on A, and in the case of N=1 we have a single-element set $A=\{a_1\}$. To indicate interrelation between models $M_1=\langle A_1, R\rangle$, $M_2=\langle A_2, R\rangle$, a concept of mapping is used, which is denoted as $G:M_1\rightarrow M_2$ or $G(M_1, M_2)$ and which puts in one-to-one correspondence an element from A_2 to each element from A_1 and a relation on A_2 to each relation on A_1.

We shall define relations between units of various levels by mapping $G_i:M_i\rightarrow M_{i+1}$; $i=\overline{1,u-1}$, which puts in one-to-one correspondence an element from E_{i+1} to each element from E_i and a relation on E_{i+1} to each relation on E_i.

The problem of developing the structure of a unitized machine system and the process of machining an item stipulates formation of machining sequence on a set of processes of machining elementary volumes of machining allowance, which

must be distributed between units of various hierarchy levels by covering the sequence of machining elements from set D on units from set M_i.

When it is necessary to link binary relations between machining elements, for instance, 001 and 002 from set J, to equipment elements, for instance, in the case of machining on unit 301 from set E_3, then 301 001·002 301 is a binary relation of sequential machining of two elements 001 and 002 on unit 301; similarly, 301 001+002 301 is a binary relation of parallel machining of elements 001 and 002 on unit 301.

When element 001 is machined on unit 301 and element 002 is machined on unit 302, then different versions of relations of "following" are possible, for instance, 301 001 301·302 002 302 and 301 001 301+302 002 302. These notations are respectively binary relations of sequential and parallel functioning of units 301 and 302 from set E_3 during machining elements 001 and 002 from set J, where unit 301 performs machining of element 001, and unit 302 performs machining of element 002.

In order to cover a set of machining elements with equipment, one should at least specify, which tools (single-component units of the 1st unitizing level) can be used for machining a given object. We shall define this information by a mapping, that compares a model of the machined object with a model of the unit of the 1st unitizing level (the tool) $G_0:D \twoheadrightarrow M_1$.

Without taking into account restrictions, the problem that is being discussed is stated as follows. Let the following be given: the object of machining $D=\langle J, R\rangle$; element unitizing base $M_i=\langle E_i, R\rangle$, $i=\overline{1, u}$, wherein permissible links between units of adjacent levels $G_i:M_i \twoheadrightarrow M_{i+1}$, $i=\overline{1, u-1}$ are identified; units of the 1st unitizing level (tooling), used for machining of a given object $G_0:D \twoheadrightarrow M_i$. For a finite sequence of elements $\{J_m\}\in J$, it is necessary to choose units from set E_i, which would together comprise a unitized machine system, applicable for machining the object.

Within the framework of this statement of the problem, model D makes it possible to generate all possible permissible and prohibited machining sequences, whereas model M_i and homomorphisms G_0 and G_i make it possible to "cover" each fixed machining sequence with equipment.

The above discussed models of the object of machining, element unitizing base and their conformances (homomorphisms) make it possible to derive all possible versions of lay-out of multi-level units, including technically and/or economically useless ones. To reduce the number of versions of structure construction and lay-out by cutting off the useless ones, one should impose certain restrictions.

Restrictions on Applicability of Structures and Units Lay-Out. A common feature of machine systems is their hierarchic character, which means, that a unit of a certain i-th level can include several uits of the (i-1)-th level, but can only be a part of one unit of the (i+1)-th unitizing unit. For instance, two tools can be installed on the same slide, but no tool can be installed on two slides at a time. Obviously, the simplest, or minimal, structure, that retains the hierarchy feature, is a lay-out version, when a

unit of the i-th level includes a single unit of the (i-1)-th level.

A single-unit lay-out structure corresponds to the minimal hierarchy structure (Figure 3, a). By combining minimal hierarchic structures, one can synthesize any version of a unitized system structure. We shall call a structure, in which a unit of the (i+1)-th level includes N units of the i-th unitizing level, an N-unit lay-out structure of the i-th level units. An N-unit lay-out structure is a natural generalization of the minimal hierarchic structure.

Two-Unit Lay-Out Structure in Case of Machining Two Elements. We shall examine the possibility of machining two elements $J_m, J_n \in J$.

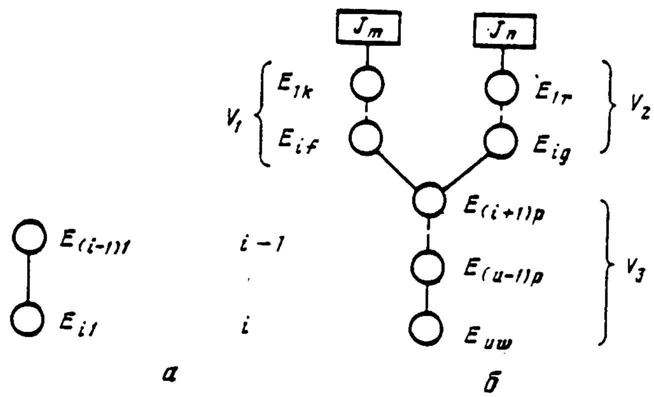


Figure 3

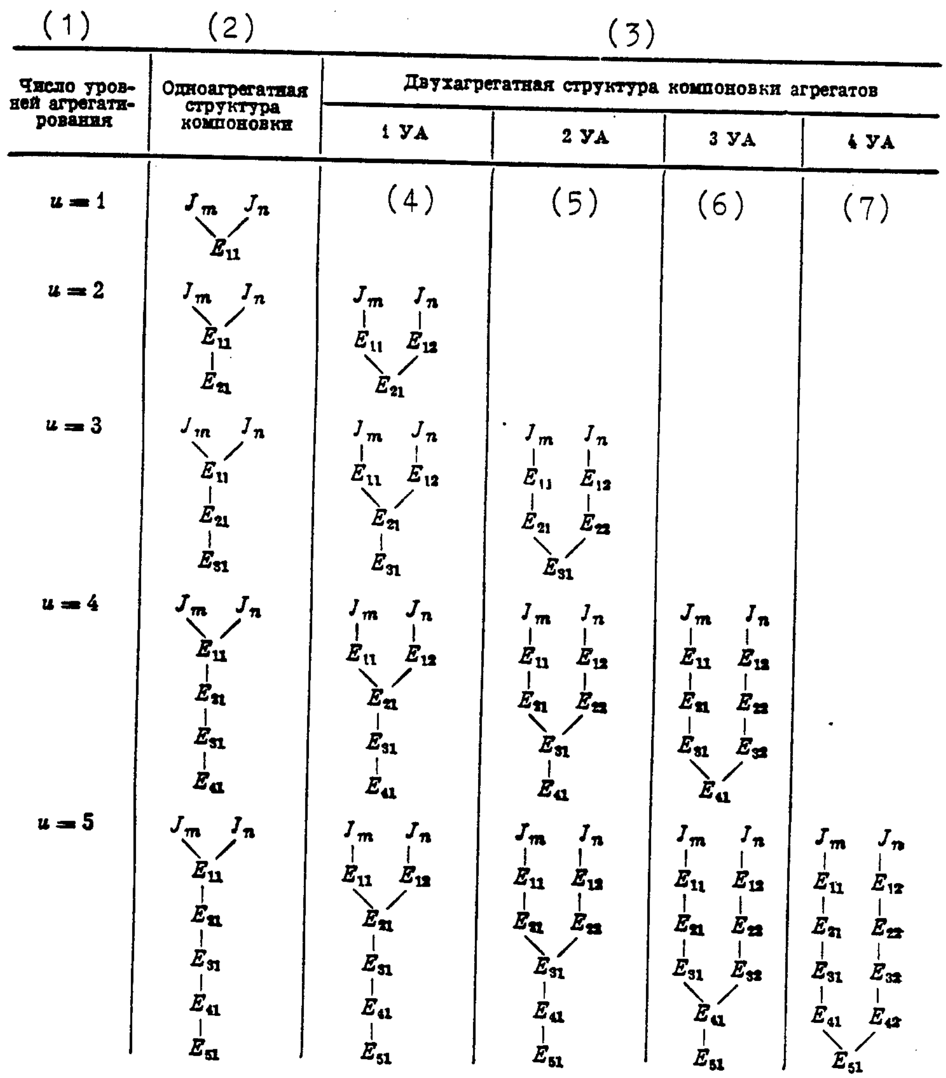
If we assume a two-unit lay-out structure (Figure 3, б,) at a certain i-th level of a multi-level unit, then this will, as a matter of fact, determine the structure of all other levels of the two-unit lay-out structure. Indeed, if a two-unit structure of a certain i-th level can be used for machining a pair of elements J^m, J^n, then at all other levels $j \neq i$ units can be only combined in accordance with a one-unit lay-out structure, due to the hierarchic character of elements of the machine system, wherein for $j<i$ there are two unit branches, and for $j>i$ there is only one branch (Figure 3, б).

Thus, if one constructs all possible versions of units lay-out for machining a pair of elements in the case of a two-unit structure at the i-th unitizing level, then structures of all units with a two-unit lay-out structure at the same level will be identical as far as machinig this pair of elements is concerned). For instance, in the case of turning, lay-out arrangements in Table 1 are vertically identical.

In Table 1 the following symbols are adopted: $J_m, J_n \in J$ are machining elements of the machined item; $E_{11}, E_{12} \in E_1$ is a set of single-level units of the 1st unitizing level (single-component units in this case), for instance, a set of tools; $E_{21}, E_{22} \in E_2$ is a set of single-level units of the 2nd unitizing level, for instance, a set of slides; $E_{31}, E_{32} \in E_3$ is a set of single-level units of the 3rd unitizing level, for instance, a set of carriages (powered tables); $E_{41}, E_{42} \in E_4$ is a set of single-level units of the 4th unitizing level, for instance, a set of units of a hydraulic copying semiautomatic lathe without units of preceding unitizing levels (headstock, tailstock); $E_{51} \in E_5$ is a set of single-level

units of the 5th unitizing level, for instance, a set of units for material handling between stations of an automated transfer line (a transfer arm for parts loading and unloading, a stepped conveyor-shifter).

Table 1



Key:

1. Number of unitizing levels
2. Single-unit lay-out structure
3. Two-unit lay-out structure
4. Single-level unit
5. Two-level unit
6. Three-level unit
7. Four-level unit

Applicability of a Two-Unit Lay-Out Structure for Machining a Pair of Elements of an Object of Machining. We shall introduce a two-position two-digit relation P_i, that identifies the applicability of a two-unit structure for a

pair of units of the i-th level for machining two elements J_m, J_n. Realization of relation $P_i(J_m, J_n)$ for a pair of machining elements means, that a given pair of elements can be machined on a multi-level unit, in which a two-unit lay-out structure is applicable at the i-th unitizing level.

Realization of relation $P_i(E_{if}, E_{ig})$ for a pair of units $E_{if}, E_{ig} \in E$ means, that, for machining two elements $J_m, J_n \in J$, this pair can be combined in accordance with a two-unit structure. Relation of applicability of a two-unit lay-out structure makes it possible to compare pairs of machining elements, as well as pairs of units.

Multivariance of Applicability of a Two-Unit Lay-Out Structure. Any two-unit lay-out structure is realized for a specific type of units functioning (parallel or sequential); besides, the units can be identical or different and can be used in a parallel or sequential machining flow. In order to take the above listed factors into consideration, we shall introduce a concept of parameters of lay-out structure applicability as a set (procession) $\langle x, y, z \rangle$, where x determines the presence of parallel or sequential machining flows; y determines the type of units functioning in time (sequential or parallel); z is the difference between units, that are combined at the i-th level of applicability of a two-unit lay-out structure:

$$x = \begin{cases} 0, & \text{sequential machining flow,} \\ 1, & \text{parallel machining flows,} \end{cases}$$

$$y = \begin{cases} 0, & \text{sequential functioning in time,} \\ 1, & \text{parallel functioning in time,} \end{cases}$$

$$z = \begin{cases} 0, & \text{different units,} \\ 1, & \text{identical units.} \end{cases}$$

Let P_i^{xyz} denote a two-valued two-digit relation of applicability of a two-unit lay-out structure of units of the i-th unitizing level with xyz parameters for machining a pair of elements. We shall define restrictions, that machining elements place on the possibility of using a two-unit structure at each unitizing level, by models of the object of machining $D_i = \langle J_i, P \rangle$, $i = \overline{1, u}$,

where $J = \{J_1, J_2, \ldots, J_n\}$ is a set of machining elements; $P = \langle P_i^{000}, P_i^{001}, \ldots, P_i^{111} \rangle$

is a set of relations of applicability on J; u is the number of unitizing levels.

We shall define restrictions, placed by units on the possibility of their joint lay-out in accordance with a two-unit structure in machining two elements, by models of levels of element unitizing base $M_i = \langle E_i, P \rangle$, $i = \overline{1, u}$ where $E_i = \{E_{i1}, E_{i2}, \ldots, E_{iL}\}$ is a set of units of the i-th unitizing level.

Restrictions on Applicability of Units of Different Unitizing Levels for Machining Elements of an Object of Machining. The possibility of machining

each machining element by a separate tool has been specified by a homomorphic mapping $G_0:D \rightarrow M_1$. We shall define a stronger restriction of applicability of units of different unitizing levels for machining of each element by a set of two-digit mappings $H_i:D_i \rightarrow M_i$, $i=\overline{1, u}$, that put a unit $J_n \in J$ in correspondence to each element $E_{im} \in E_i$.

We shall define the restriction on using units in parallel and sequential machining flows by multivalued mappings $G_i^x:M_i \rightarrow M^{i+1}$, $i=\overline{1, u-1}$, where $G_i^x=G_i^0$ indicates the possibility of units lay-out for using them in a sequential flow, whereas $G_i^x=G_i^1$ indicates this possibility in parallel flows.

If one considers G_i^x as a multivalued mapping, then its value L>0 for a pair of units $E_{im}, E_{(i+1)n}$ indicates, that units lay-out is possible and that L units E^{im} can be installed on unit $E_{(i+1)n}$ for use in a parallel or a sequential machining flow. For brevity, this can be written as $L_i^x=G_i^x(E_{im}, E_{(i+1)n})$.

Machining Elements as Zero Unitizing Level Units. Formally, machining elements can be considered zero level units, i.e. $J=E_0$. In this case, relation, that determines the possibility of using a two-unit lay-out structure, will determine at the zero level the possibility of machining two elements with one tool. We shall construct a model $D_0=\langle J, \{P_{0}^{xyz}\}\rangle$ and $M_0=\langle E, \{P_0^{xyz}\}\rangle$. Because $J=E_0$, these models are identical, i.e. isomorphic, and mapping $H_0:D_0 \rightarrow M_0$, that compares them, is also isomorphic.

Taking into account the above examined restrictions, statement of the problem of designing the structure and lay-out of a unitized machine system is reduced to the following. Let element unitizing base $M_i=\langle E_i, P_i\rangle$, $i=\overline{1, u}$ be specified and permissible unit lay-out versions $G_i^x:M_i \rightarrow M_{i+1}$, $i=\overline{1, u-1}$ identified. For a given object of machining and taking into consideration restrictions on applicability of a two-unit lay-out structure $D_i=\langle J, P_i\rangle$, $i=\overline{\varnothing, u}$ and restrictions on applicability of units for machining each element $H_i:D_i \rightarrow M_i$, $i=\overline{1, u}$ it is required to select a subset of units, that satisfy structures applicability relations, and define permissible versions of structure of a unitized system, formed by these units.

Criterion of Applicability of a Multi-Level Unit With a Two-Unit Structure at the I-th Level for Machining Two Elements of the Object of Machining in the Unitizing Process. On the decomposition region of machining elements J and element base E_i, a machining route diagram and the structure of a unitized system of automatically operating machines is formed. Formation of versions is considered as a process of multi-level unitizing of the machining process, the structure and the lay-out of a system.

We shall assume, that for a pair of machining elements $J_m, J_n \in J$ relation $R(J_m, J_n)$ is satisfied. If, for a given pair of machining elements and a pair of the i-th level units E_{if} and E_{ig}, relations of applicability of a two-unit lay-out structure (we shall denote such intersection as K_0) $K_0= =P_i^{xyz}(J_m, J_n) \wedge P_i^{xyz}(E_{if}, E_{ig})$ are simultaneously satisfied, then it is possible to determine the structure of all other levels. The only other thing to be done is to select units, applicable in the structure of Figure 3,*б*. For introduced mappings H_i and G_i, we shall denote the comparison between pairs of

elements of sets of various models by relation between $H_i(J, E_i)$) and $G_i(E_i, E_{i+1})$.

We shall denote conditions of applicability of units in "branches" V_1, V_2 and V_3, (Figure 3, б) by K_1, K_2 and K_3, respectively, where

$$K_1=[\bigwedge_{l=1}^{i} H_l(J_m, E_{lk})]\wedge[\bigwedge_{l=1}^{i-1} G_l^{z}(E_{lk}, E_{(l+1)f})], \quad K_2=[\bigwedge_{l=1}^{i} H_l(J_n, E_{lr})]\wedge$$

$$\wedge[\bigwedge_{l=1}^{i-1} G_l^{z}(E_{lr}, E_{(l+1)g})], \quad K_3=[\bigwedge_{q=i-1}^{u} H_q(J_m, E_{qp})\wedge H_q(J_n, E_{qp})]\wedge$$

$$\wedge[\bigwedge_{q=i+1}^{u-1^{*}} G_q^{z}(E_{qp}, E_{(q+1)e})],$$

determine the possibility of combining units for machining elements J_m and J_n.

We shall denote the possibility of simultaneous installation of units E_{if} and E_{ig} on $E_{(i+1)p}$ as $K_4=G_i^{z}(E_{if}, E_{(i+1)p})\wedge G_i^{z}(E_{ig}, E_{(i+1)p})$.

Then the possibility of forming a multi-level unit with a two-unit lay-out structure at the i-th level for machining elements J_m and J_n (Figure 3, б) is contingent upon simultaneous satisfaction of the above listed applicability conditions, i.e. condition $K= R(J_m, J_n)\wedge K_0\wedge K_1\wedge K_2\wedge K_3\wedge K_4$. must be satisfied.

Relations between several elements from J and elements from E_i, that are larger than two, lead to more complicated recording of formulae for relations between groups of elements from sets J and E_i, to construction of a structural logic formula for machining sequence (route) and of the structure of a unitized system. A version of the structure of a unitized system of automatically operating machines and machining route, using machining the part in Figure 1 as an example, with a set of elements $J=\{001, 002, \ldots, 008\}$ of this part, using element unitizing base from set E_i (Table 2), is presented in Figure 4.

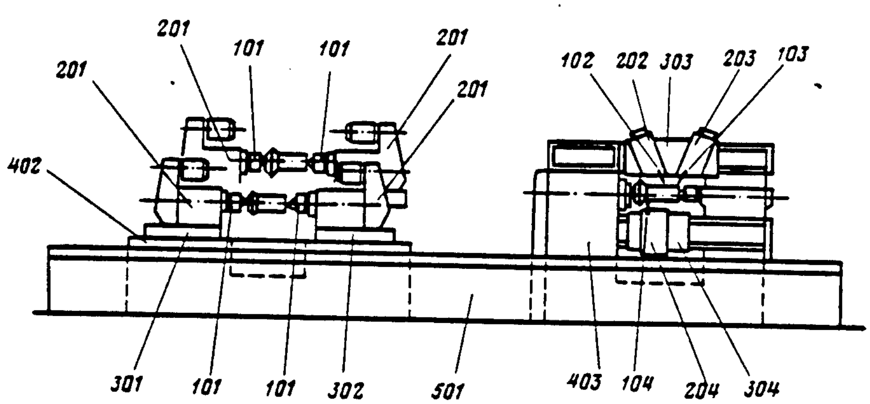


Figure 4

For the version of a unitized system under consideration, the structural logic formula has the following form:

601 501 402 301 201 101 001 101 201 301+301 201 101 001 101 201
301+302 201 101 002 101 201 302+302 201 101 002 101 201 302
402+403 303 203 103 008·003·005·004 103 203·202 102 006 102
202 303+304 204 104 007 104 204 304 403 501 601

Table 2

Level of Unitizing	Description of Unit	Code
1	Combined center drill	101
	Straight-turning tool, left-hand side	102
	Straight-turning tool, right-hand side	103
	Facing tool	104
2	Spindle head for centering/facing semiautomatic machine tool	201
	Hydraulic copying slide, left-hand side	202
	Hydraulic copying slide, right-hand side	203
	Facing slide	204
3	Left-hand side carriage of centering/facing semiautomatic machine tool	301
	Right-hand side carriage of centering/facing semiautomatic machine tool	302
	Upper carriage of hydraulic copying semiautomatic lathe	303
	Lower carriage of hydraulic copying semiautomatic lathe	304
4	Bed and clamping devices of centering/facing semiautomatic machine tool	402
	Headstock with chuck, tailstock and bed of hydraulic copying semiautomatic lathe	403
5	Equipment for material handling between stations with loading-unloading autooperator	501
6	Equipment for material handling between automated transfer line sections	601

According to the structural logic formula, we have a two-station automated line (Figure 4), that includes, firstly, a centering/facing semiautomatic machine tool for two-position machining of parts (Figure 1) for machining elements 001 and 002, and secondly, a hydraulic copying semiautomatic lathe for machining elements 003, 004, 005, 006, 007, 008, wherein both semiautomatic machines are connected by means of equipment for material handling between stations.

Thus, the process of covering machining elements with equipment element base must be conducted simultaneously with forming the machining route. Comparison of models of the object of machining with the equipment base is based on unification of element structures of a unitized system. Formalizing the description of structures of design objects is necessary for developing computer-oriented algorithms for the design and development of systems for automated design of a unitized system of automatically operating machines at the structural synthesis stage.

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MECHANIZED STORAGE OF MOLDING MATERIALS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 3, Mar 86 p 16

[Article by engineers V. M. Shkolnykh, Yu. B. Usachev, and Yu. K. Azaryants]

[Text] At one of the factories (in Leningrad), low-efficiency mechanization and manual labor is used in PRTS [loading-unloading and warehouse-transportation] work. Under the effect of atmospheric precipitation, especially during the fall-winter season, the supply of sand to the dryer installation and drying process itself become laborious, expensive operations, which increases the consumption of valuable liquid fuel. In addition, the handling of loads at that time requires the use of a large number of workers to clean the railroad rolling stock.

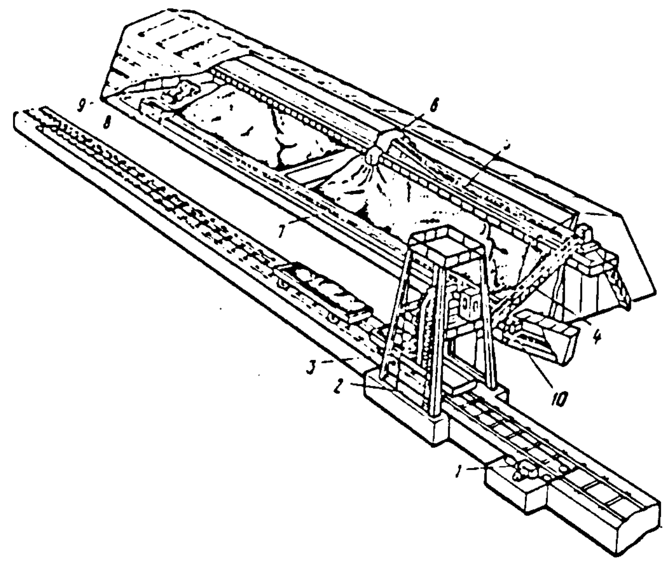
The high level of the groundwater table makes it impossible to sink the loading bin into the ground.

At the Kharkov Design and Development Technological-Experimental Engineering Institute (PTImash), a system has been developed for the comprehensive mechanization of the storage of molding materials.

The system involves the use of a dismountable prefabricated metal warehouse structure and high-efficiency PRTS equipment batch-produced by domestic industry.

The warehouse is divided into two sections proportional to the volume of the incoming sand (two types).

Five loaded flat cars on the railway overpass (see figure) are moved by a locomotive drive *1* under the bucket-lift unloader *2* installed in a stationary position on the overpass. Bucket elevator *3* and stockpile belt conveyor *4* of the unloader transport the sand onto the overhead belt conveyor *5* of the warehouse. The belt conveyor has an automatic dumping



Mechanized storage of molding materials.

cart *6*. The cart facilitates uniform distribution of sand and the maximum filling of the warehouse space. The sand is carried onto the belt conveyor *10* of the drying plant by the floor-type belt conveyor *7*, which is loaded through the load-receiving bin *8* by the bucket loader *9*.

Specifications

Annual sand influx, metric tons: 16,300
Storage reserve, metric tons: 6,250
Warehouse area, m^2: 1305
Area utilization rate: 0.68
Time of unloading a flat car, min: 20

The introduction of the project will make it possible to fully mechanize PRTS work in the storage of molding materials and yield an annual saving of 600 metric tons of liquid fuel.

The economic effect from the project will amount to 51,200 rubles per year saved.

9922
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URALMASH SPEEDS RENOVATING OF METALLURGICAL GIANT

Moscow PRAVDA in Russian 30 Apr 86 p 2

[Article by V. Danilov and V. Cherepanov, PRAVDA correspondents in the Sverdlovsk and Chelyabinsk Oblasts: "Slogan: Magnitka"]

[Text] During a meeting with workers at Togliatti, M. S. Gorbachev expressed the need to foster and strengthen the good socialistic tradition of solidarity among workers' collectives. As an example of contemporary labor solidarity, he cited interaction between the two renowned industry giants, Magnitka and Uralmash, who have joined forces in an effort to create highly-efficient technology for metallurgy aimed at acceleration of the overhaul of this branch.

At the present time, the Magnitogorsk metallurgical combine is on the verge of rebirth. According to specialists, what is about to happen is a thoroughgoing renovating: almost half of the capital equipment has been in operation for more than 35-40 years. The prime requisite for a radical overhaul is the steel smelting industry. In place of the presently operating Martensitic mills, a huge oxygen converter plant is to be constructed. Construction on first phase is slated to start in 1989. Mighty aggregates capable of providing continuous billet casting will obviate the need for present-day blooming mills. Plans also call for startup of a giant "2000" mill for hot rolling of sheet steel as well as the introduction of a number of other major complexes. Projected overall expenditures for the reconstruction will run in excess of one billion rubles.

Dozens of scientific-research and planning-design institutes as well as hundreds of factories and associations are involved in the development of designs and production of the technology, instruments and equipment. For the first time in practice, equipment planning and technology refinement are being conducted on site along with construction work. Such an integrated system of design and construction contributes significantly to an overall reduction in payback time. In addition, this system also calls for a high level of coordination and teamwork on the part of all involved.

So why all the concern? A year has passed since the decision was made to institute a thoroughgoing refurbishment of the flagship industry of ferrous metallurgy. However, the numerous ministries and departments ordered to become actively involved in this have yet to realize the importance of the task at hand. How else can you explain, for example, the position of Mintyazhmash workers who not only failed to submit in time basic data on a key part of the equipment for construction planning, but also have yet to determine who will do the fabricating. Or take this fact. In conjunction with the commissioning of new facilities at the combine it is necessary to develop a system for supplying the Magnitogorsk industrial complex. In spite of the fact that numerous directives have been issued on the subject, neither the USSR Mintyazhstroy nor Minmontazhspetsstroy nor Minergo has been in any hurry to carry them out, thinking rather, that someone else ought to do it.

Another source of alarm is the equipment already in use in metallurgical plants but which is in need of minor modifications....mechanical engineers are trying everything possible to pass it off as new, demanding that the general designers work up requisitions, technical-financial validation and patent research, all of which slows the design and construction schedule.

"We are keenly aware that success depends in large measure on how we manage to regulate the business interaction with our partners, to what extent in terms of operations and responsibility, we approach the solving of problems which arise, and how closely we observe established timetables and mutual obligations," relates deputy partcom secretary of the Magnitogorsk metallurgical combine, V. Sobko. "It was for this reason that we appealed to the collectives of enterprises and organizations involved in the reconstruction to deliver orders for Magnitka right on schedule while also maintaining high quality standards. This appeal was directed primarily at the renowned collective Uralmash which is supposed to make a major contribution to the refurbishing not only of our combine but of other enterprises of the sector as well."

For their part, the Magnitogorsk people have committed themselves to providing every possible assistance to the

equipment fabricators in high quality metal, and to deliver production strictly in accordance with orders placed. And they are backing their words with actions. During the first quarter of this year, all the structural steel was unloaded by order of Uralmash ahead of schedule and more than one thousand metric tons were additionally shipped toward future deliveries. It goes without saying that the interests of other customers did not suffer as a result.

Conversely, in order to accelerate implementation of established plans, the collective of the combine revealed an uncommonly thrifty approach to the matter and took it upon itself to incorporate economical new brands of steel, thereby freeing for the needs of the national economy no less than one half million metric tons of metal during the renovation period. Why exactly this figure? That happens to be the exact amount needed for outfitting an oxygen-converter plant and for fabrication of its equipment.

The committments on the part of Uralmash for the 12th Five-Year Plan envisage a production output increase in excess of 1.3-fold, for producing a 15 million ruble surplus above production stipulated by the plan, and by 1990, to issue all relevant certifications corresponding to the highest levels of quality. Among these products are 19 machines for continuous bloom billet casting.

"Four of them," explained the project's chief designer, P. Soloveychik, "are intended for the Magnitogorsk combine. We are endeavoring to apply our knowledge and experience in the creation of a technology which will not be merely on a par with the best world examples, but which will actually surpass present standards to meet the needs of tomorrow."

The chief designer produces a drawing:

"This is a continuous billet casting machine. In appearance, it is like the first one produced 20 years ago and presently in operation at Komsomolsk-on-Amur. However, it is many times more productive, features improved control and is more economical. Such a machine will make it possible for the first time in world practice to pour steel into two and three channels, depending on the size of slabs to be produced. By itself, the initial phase of the

renovation of the combine's steel smelting production will net the national economy savings in excess of 38 million rubles.

That is a remarkable prospect. It has inspired the trailblazing designers from Uralmash to create similar machines, or actually, not just the designers, but the entire collective of associations. The program for reconstructing Magnitka was discussed at a meeting of the Uralmash active party-economic membership held last year. It was discussed, approved and adopted for execution. Supervision of its implementation was assumed by the Sverdlovsk and Chelyabinsk CPSU Obkoms. Specialists from the association spent some time in Magnitogorsk while representatives of the combine stayed in Sverdlovsk. This marked the beginning, so to speak, of a reciprocal movement aimed at a single objective.

As a result, the engineering project for an all-new machine for continuous billet casting was completed in six month's time despite the fact that it normally takes ten months to design less complicated plants. The working drawings will also be completed ahead of the scheduled date.

Technologists are gearing up for action. In minimum time, they will have to streamline the fabrication of components and subassemblies of future machines for continuous billet casting. The volume of metal used in the new machines will have to be reduced by 20 percent.

Actualization of plans will be made possible by introduction of advanced technologies based on plasma-mechanical and electrical contact methods of machining components from high-strength steels plus electron-beam welding and fusion, plasma cutting and plasma-jet spraying. A bay was recently put into operation for fabricating welded hard-alloy tools whose use has brought a 10-15 percent speed increase in cutting modes as well as a boost in component machining accuracy.

Around Uralmash, the word "Magnitka" has begun to sound like a slogan. Following the example of the first Uralmash workers and builders of the Magnitogorsk combine, workers' brigades have now armed themselves with the battle

cry "The Five Year Plan in Four Years!" In so doing, they are setting their sights high. Initiators behind the movement for early fulfillment of objectives were the lathe-workers headed by Hero of Socialist Labor A. Korolev. This initiative met with widespread support on the part of the mechanical engineers.

"To renovate the primary equipment of the steel smelting industry of the Magnitogorsk metallurgical combine..." as it states in the Draft Guidelines. It is highly symbolic that the overhaul of the sector is beinning with its flagship industry. Let us remember: in the thirties the entire country lent a hand in the erection of Magnitka, that mighty bastion of socialist industry. And now we are faced with the task of advancing our metallurgy to the upper limits of scientific-technical progress. Therefore, may the legendary name "Magnitka" become for each renovation worker a slogan for the same efficient labor cooperation as at Uralmash.

12978
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PATTERN LAYOUTS

Baku VYSHKA in Russian 18 Feb 86 p 2

[Article by V. Aliyev under the "Scientific and Technological Progress" rubric]

> [Text] "To ensure that the key political and economic challenge of accelerating scientific and technological progress in all possible ways is met. To increase decisively the role of science and technology in qualitatively transforming the productive forces, in redirecting the economy toward inclusive intensification, and in enhancing the efficiency of social production. To bring scientific and technological development more firmly to bear in tackling societal tasks."

From the draft document "Fundamental Directions"

Another metal pattern layout production line, developed by specialists at the Baku department of VNIITelektromash, has gone into service at the Electrical Machine Building Plant imeni 50th Anniversary of the Azerbaijanai Komsomol. The fifth and final line is due for start-up shortly. After that line is in operation, all the electrical sheet steel purchased by this enterprise for the manufacture of core laminations for 4A-200 and 4AM-132 motors will be formed by this less wasteful method.

The automatic die-forming section, where the new lines have been installed end to end, is hushed for the moment. The automatic presses, which would normally be rumbling ponderously and monotonously banging their dies down on sheets of metal, have fallen silent, as though biding their time. But the lines are presently being readied to start work. The die-press operators A. Agarigimov, M. Azimov and D. Guseynov, and N. Guseynov, deputy amalgamated brigade leader, are doing the set-ups with a steel roll slung from a gantry crane.

"In point of fact, this section of ours had become redundant," A. Markarov, deputy technologist at the Azerelektromash production association, said. "We didn't do any blank layout at all here. We got all our electrical sheet steel in straight-edge rolls like this but they were much narrower, the width of one core stator lamination. There wasn't any preliminary blank layout they were taken straight into the next section, where they were die-forged on the automatic presses.

"The die-forged sheets were circular. We know from our school geometry courses that when you try to cover a square surface with a circular piece you are going to end up with something left over at each corner, no matter how you go about it. Everything that was left over after the core laminations were forged was scrapped. But isn't it possible to go through the metal in a less wasteful way? That was the question which exercised specialists in the Baku department of VNIITelektromash.

"It didn't take them long to come up with the idea of creating a new production line which would be instrumental in allowing the electrical machine building plant to cut, for the first time ever, the widest strip steel that our metallurgical industry is currently capable of producing. But the cutting was to be done in such a way that the core lamination patterns would be laid out in a sort of checkerboard arrangement.

"This cutting method turned out to be significantly less wasteful. Some 7 or 8 percent of the electrical sheet, a commodity which is in acutely short supply could thus be saved from wastage."

Meanwhile, the section presses were working away. The moving strip on the cutting lines stopped for a moment. The dies sliced into it, leaving clear traces. And, lo and behold, the broad roll was slit into three strips with wavy edges which were then wound onto rotating spools at the far end of the line.

The die-press operators were already at their consoles, from where they would direct the press, the movement of the strip, the rotation of the spools...

Shortly after being cut, the patterned lengths would be transferred to the other section, where they would be die-forged into core laminations.

The proposal made by the specialists in the Baku department of VNIITelektromash was tempting indeed. It promised major savings. But it meant that the plant would have to install five brand-new production lines and send all the rolled metal purchased by the plant through those lines. The idea was that three of them would service the section which produced core laminations for the 4A-200 series motors and the other two would do the work for the 4AM-132 series motors. But there was just one catch. The new technology required the steel strips to be die-forged twice: the first time during the preliminary layout and the second time when the laminations were manufactured. Was there any way of ensuring that the mandatory precision would be achieved? Under such circumstances, after all, deviations--sheets varying from the standard dimensions--could possibly show up. And that output would be rejected, which was something that could certainly not be tolerated.

But the staff members of the Baku department of VNIITelektromash managed to solve that problem.

"While some were developing the new pattern layout lines," R. Talyshinskiy, deputy director of the Baku department, said, "a group of specialists here were busy creating a special coating for the steel which improves its workability. That coating is now common knowledge. It is on the State All-Union Standards listing as mandatory for certain types of steel."

The Baku electrical machine building plant got its first pattern layout line at the end of 1983. It was also the first such line in the country's entire electrical engineering sector.

"Things were tense," F. Ismaylov, deputy chief engineer at the Azerelektromash production association, said. "As groundbreakers we had a slew of questions to resolve. We had to order new machinery from the Zaparozhskiy special manufacturing equipment plant and set it up... and even contract with the Cherepovetskiy metallurgical plant, which supplies us with electrical sheet steel, to have them deliver the metal to us in wider rolls. But the metallurgists were delighted to get that order. After all, we were saving them the trouble of slicing the strips into lengths as narrow as a single magnetic circuit lamination. The steel, moreover, was easier to transport. Large-dimension steel rolls present no particular haulage problems."

The Baku electrical machine building plant now has plenty of imitators. Pattern layout lines have gone, or are going, into service in several plants across the country. And people invariably come to Baku to see how it is done. It was here that the lines were developed and here that they first went into operation... And in the first year alone, use of this new equipment at the Baku electrical machine building plant, which still does not have all its pattern layout lines up and running, resulted in economies of over 800 tons of costly electric sheet steel. The metal thus saved is now used to make a full set of magnetic circuit laminations for one in approximately every nineteen 4A-200 series electric motors. When the last line is started up, every twelfth motor of the other series will also be fitted out with laminations made from steel that would otherwise have gone to waste.

The scraps flow slowly from the automatic die-press shop sections into a special container. They get there on conveyer belts that run unseen under the flooring. But the moment that the container's contents reach a certain level, the boom of a gantry crane operated by M. Guseynova comes swooping rapidly over and plunges an enormous electromagnet into it. With another swooping movement, the intricate metallic shapes, stuck firmly together in a shaggy-looking magnetized ball, are transferred to an automatic press.

"The bulk of them will go back to Cherepovets to be resmelted," A. Markarov said. "And when the fifth line is brought on, we will have less scrap."

Scrap reduction is also occupying a lot of people at the Baku department of VNIITelektromash.

"At the present time we are working on improving the pattern layout production line," said F. Agazade, director of the Baku department. "In particular, new die design criteria and actual die designs are being developed. When those designs are introduced, the layout patterns will produce far less waste, and it will be possible to conserve another 2 or 3 percent of the electric strip steel. But that will not involve the additional expenditures that were called for initially, when the production lines were first commissioned."

The metal-conserving campaign continues...

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"RADIAN" NC SYSTEM FOR SPECIAL LATHE-DRILLING-MILLING MACHINE

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 10, Oct 85 pp 18-19

[Article by Candidate of Technical Sciences S. V. Suyarko and engineers A. P. Reshetnikov and V. N. Grinchenko: "'Radian' Numerical Programmed Control System"]

[Text] The "Radian" NC system is designed to control the faceplate turning angle of a special lathe-drilling-milling machine for drilling and milling operations.

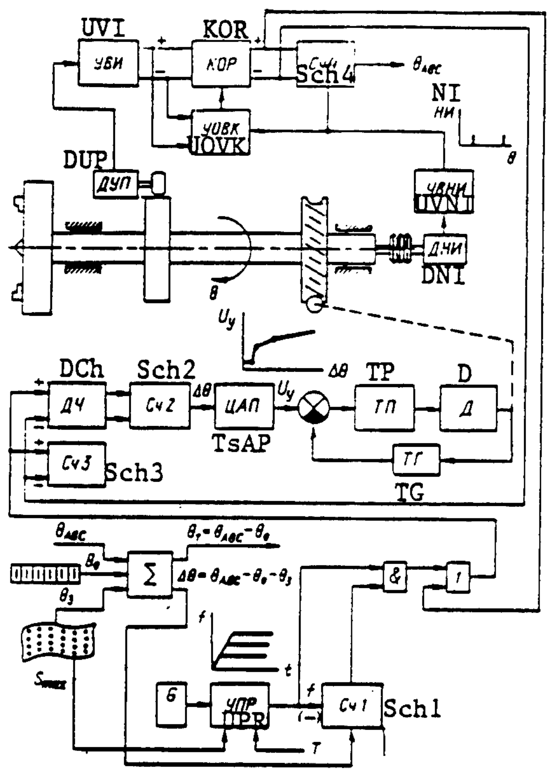
When drilling, the system controls the faceplate positioning angle at maximum speed. When milling, the system controls the angular positioning of the item during cutting and the angular feed speed.

The amount of travel and speed are preset from the Razmer 2M NC system.

A block diagram of the "Radian" system is given in the drawing [following page]. The preset turning angle θ_z, angle θ_{ABC} read from the zero pulse, and angle θ_0, corresponding to the selected read start, are fed to adder input Σ.

The adder computes the actual turning angle from the selected read start $\theta_t = \theta_{ABC} - \theta_0$ (feed to display) and the angle to be processed $\Delta\theta = \theta_z - \theta_t$ (feed to drive processing). The UPR (smooth acceleration subassembly) smooths the drive acceleration. Pulses from frequency generator G, the preset maximum speed S_{max} and acceleration time to maximum speed T (machine tool parameter) are fed to the inputs of this subassembly. S_{max} determines the frequency generator count-down ratio. T determines the frequency of the pulses being fed to a supplemental UPR counter. The counter fill time corresponds to the linear acceleration time of the drive. Counter Sch1 will be filled by pulses from the UPR output so long as its contents do not equal 0, that is, until a number of pulses corresponding to the value of processing angle $\Delta\theta$ reaches the Sch1 input. Until that time, pulses f move from the UPR output through channel I to the outputs of the two Sch2 and Sch3 counters. At the input to Sch2 the pulses pass through frequency divider DCh. The DCh division coefficients are assigned by linear counter Sch3. Feedback pulses are fed to the subtractor inputs of both counters with a measuring unit. The contents of Sch2 are converted by a 12-bit digital-to-analog converter into analog voltage U_y, which is fed to the feed drive input, which switches on thyristor transformer TP, motor D and tachogenerator TG.

Block Diagram of the "Radian" System



A contactless resolver with 50 pairs of terminals is used as the measured turning angle sensor DUP, and the same resolver, but with a built-in optical sensor of a single pulse per revolution of the shaft, is also used as the zero pulse sensor DNI. The sensors are powered by two-phase voltage at a frequency of 2.5 kHz. A pulse generation subassembly UVI in the form of an electronic tracking system with each period compensating for the mismatch between sensor reference and input signals is used to pick off information from the DUP output in the form of a unitary code. The phase period is divided by 200, which corresponds to 10,000 pulses per revolution of the sensor shaft.

In the zero pulse generation subassembly UVNI, the optical sensor single signal is gated by the hundredth pulse of the zero-pulse resolver-sensor. Coincidence of these pulses yields a zero-pulse read.

The measuring unit uses a KOR transfer ratio corrector for the i-th friction pair; the sensor roller is the measuring disk. In order to obtain 360,000 pulses per faceplate revolution, i is taken to equal 36. When manufacturing the friction-pair disk and roller, the tolerances field for its elements is chosen so as to obtain i greater than the calculated value (disk with a plus tolerance and roller with a minus tolerance). Before the system begins operating, a set-up revolution of the faceplate is done so that the adjustment value setting subassembly UOVK can set the turning angle between two zero pulses.

This measurement obtains an angle greater than 360,000 samples. Subsequently, when the system is operated at a turning angle of 360°, all "surplus" pulses distributed evenly about the turning angle are subtracted.

Counter Sch4 stores the amount read from the zero pulse.

The "Radian" NC system can operate in the following modes: set-up revolution, reference faceplate travel, drilling, milling, continuous rotation.

In the set-up revolution mode, the faceplate is turned to an angle from 360 to 720° at a speed of 0.4 rpm to absolute zero-set the system and to automatically calculate the value of correction i.

In the reference faceplate travel mode, measured (0.001°, 0.01°, 0.1°, 1°, 10° and 100°) or arbitrary intermittent faceplate travel is done from "clockwise" and "counter-clockwise" pushbuttons. The speed of arbitrary intermittent travel is chosen from the series $0.01\omega_{max}$, $0.2\omega_{max}$, ω_{max}.

In the drilling mode, the angular positioning of the item is done at the maximum speed permissible for the assigned angle and signals are exchanged between the "Radian" NC system and the "Razmer 2M" NC system to set up the automatic drilling cycle.

Angular positioning of the item during the cutting process, at an assigned angular feed speed, is done in the milling mode.

The continuous rotation mode is used when machining the outside surface of an item by strip milling. In this mode, the system controls the faceplate rotation speed, adjusted within a range of 0.001 - 1 rpm.

The control voltage supplied to the drive depends on the value of the turning angle remainder. The drive is accelerated and slowed at the end of the machining linearly, with dragging in the vicinity of the machining point. The drag speed and route are regulated. Time of acceleration to maximum speed is regulated within a range of 1 - 32 sec. Error accumulation when working incrementally is eliminated. All this ensure the required precision and minimal time for the assigned travel. The turning angle is preset decimally within a range of 0 - 360° in absolute amounts of the base selected or in increments. The turning angle is displayed in absolute-zero selection, in selected base and in increments. When necessary, return to absolute zero is possible.

Technical Data

read discreteness, degrees	0.001
number of decimal digits	3.3
read start bias, degrees	up to 360
maximum positioning and angular feed speed, rpm	1
range of angular feed speed adjustment	1:1,000
drive control voltage, V	±10

The NC "Radian" system is in use at various enterprises on KSPO machine tools (Kramatorsk). The economic impact of machine tools equipped with the "Radian" NC system results from the improved productivity over

machine tools without NC systems and from eliminating time spent on manufacturing installing and adjusting jigs previously used when drilling parts.

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- END -